1968

Approximation of the export employment structure of functional economic areas

Marvin Gottfried Julius
Iowa State University

JULIUS, Marvin Gottfried, 1922-
APPROXIMATION OF THE EXPORT EMPLOYMENT
STRUCTURE OF FUNCTIONAL ECONOMIC AREAS.

Iowa State University, Ph.D., 1968
Economics, general

University Microfilms, Inc., Ann Arbor, Michigan

APPROXIMATION OF THE EXPORT EMPLOYMENT STRUCTURE OF FUNCTIONAL ECONOMIC AREAS

by

Marvin Gottfried Julius

A Dissertation Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major Subject: Economics

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

Head of Major Department

Signature was redacted for privacy.

Dean of Graduate College

Iowa State University
Of Science and Technology
Ames, Iowa

1968

TABLE OF CONTENTS

I. INTRODUCTION

A. Objective of This Study

The objective of this study is to formalize a method for the rapid and inexpensive quantitative estimation of the economic base of a functional economic area. This type of endeavor is by no means a new one in the field of economic science. There is an abundant backlog of published literature dealing with the general topic of the economic base. Arguments surrounding the economic base concept have rivaled in intensity the controversy over the marginal concept. The main discussions of the two controversies took place during approximately the same period of time, and the economic base controversy has not yet produced a consensus of agreement.

In spite of disagreements regarding the usefulness of economic base theory, the application of this theory has proceeded rapidly. Many attempts have been made to measure the economic base of communities, counties, areas, cities and states. The measurements obtained have been used in various ways to describe, to explain and to predict or project economic activity. A comprehensive review of economic base mechanics in both theoretical and applied phases and with references to associated studies is in the form of a series of articles by Richard Andrews (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12). The bibliography to an article by Homer Hoyt contains a large list of applied economic base studies (20, pp. 186-191).

B. Economic Base Definition

The term "economic base" is usually used in the context of a money economy. The economic activities that produce a flow of money income into the area constitute the economic base. Since an inflow of money is usually produced largely by an export of products, the economic base is often called the export base, and the associated economic activities are known as export activities.

Additional understanding may be gained by looking at those activities that are not part of the economic base. In all areas that have an active exchange economy a number of economic activities take place which do not directly produce any export products. Rather, all of the products produced by these activities are consumed locally, and no more are produced than what the local market will absorb. These activities do not produce an inflow of money to the area but circulate that money which is already in the area. Activities with the aforementioned characteristic are categorized as non-basic or by descriptive terms such as domestic, residentiary, adaptive and others. In this manuscript, the term, "residentiary" is used almost exclusively except where quotations are made from sources which used terms that can be interpreted as closely synonymous with "residentiary".

In a causal sense, it is presumed that export activity exists because of some comparative advantage possessed by the given area in the production of the exported products.

Residentiary activity exists because the total economic activity of the area creates product demands which can be filled by such activity at a lower cost than by importing the desired products. In addition, there are many desired products which can be imported at a lower cost than they could be produced locally. The purchase of these imported goods creates an outflow of money which, in general, balances the inflow produced by the export activity.

Export activity, residentiary activity and import purchasing will all be found in any area which is less than world-wide in size or, if smaller, is not completely isolated from the rest of the world. Among interacting areas, the smaller the area the greater is the proportion of economic activity which will be classified as export. As area size expands, residentiary activity becomes an increasingly larger proportion of the total.

C. Uses of Economic Base Measurements

The primary interest in economic base measurement can be said to arise from its usefulness in describing, explaining and/or predicting changes in economic activity. In general it is assumed that, all else being equal, the area with the larger economic base will have a larger associated residentiary sector so that total economic activity is some predictable multiple of basic activity.

Some studies may be designed to determine which sectors of economic activity are basic to the area and, of these, which are most important. Policymakers may wish to give such sectors preferential treatment or at least insure that they are not given detrimental treatment.

Other studies may reveal whether the areas are heavily dependent on one or two export sectors which may be in, or are about to enter, a period of rapid change. If the change is an increase, planners will be alerted to prepare for rapid increases in population which create demands for the expansion of many types of community facilities. If the change is a decrease, community leaders may wish to either expend unusual efforts to build up an expanding export base in some other sector or sectors or, alternately, they may begin plans for a "graceful" decline in community size.

Many studies have been undertaken for the express purpose of determining a value of the multiplier which associates the basic activity to the total economic activity of the area. Such studies normally can provide an average ratio. If this ratio is assumed to approximate closely the marginal multiplier, the community then has a usable estimate of the direct and indirect effects which would be associated with changes in export activity.

D. Orientation of This Study

Many economic base studies for which empirical data were gathered have indicated that all sectors of an area will have some export activity. The leading sectors in this respect might be easily identifiable by casual inspection of the area or of secondary data describing the area. However, it can happen that a large part of the total export activity is represented by sectors which individually are ranked third, fourth or even lower according to the percentage which each sector represents of the total export activity. In this situation it is helpful to attempt to describe, with reasonable quantitative accuracy, the export status of each sector of the economy of the area.

The primary emphasis of this study is to make possible such a quantitative estimate of the export activity of each industry sector for any given area.

A number of investigators have wished to make projections of export and residentiary activity in areas, regions or cities. In most cases census data have been used to provide control totals of economic activity in units of employment, value-added or total sales. The census totals have then been divided into export and residentiary categories by applying appropriate ratios against such totals. These ratios have been obtained either by the expensive and time-consuming method of surveying business firms of the area being studied, or by using crude approximations regarding the magnitude of the ratios to be used. These approximations are not necessarily *a priori*, but are usually related to other studies of areas which are in some degree similar to the one for which approximations are needed.

This study concentrates on the derivation of more refined approximations and an effort to test these approximations for realism against a considerable amount of data already in existence.

The approximations which are developed in this study relate almost entirely to functional economic areas. Functional economic area is the term for the concept developed most recently, and in most detail, by Karl A. Fox (18, pp. 344-370). In the midwestern United States the terminology refers to areas comprising a central city, some smaller cities and towns and a rural-farm area.

Originally the economic base concept was almost universally applied to urban areas, and the almost universal term used in earlier literature was that of "urban economic base". The functional economic area does not exclude the urban area, but does add to it a set of smaller towns and open-country areas all of which are, roughly speaking, within the trading and labor market area of the urban center.

The functional economic area differs from the strictly urban area in that agriculture is included as one of the important sectors in the former. For that reason, and because some other open-country activities such as outdoor recreation may be included, the functional economic area will usually provide a wider sectoral range of economic activity for analysis than will the urban area.

II. REVIEW OF LITERATURE

A. Roots of Economic Base Theory

The economic base concept appears to have originated in the work of urban planners. Blumenfeld (13, p. 115) credits an American planner, Frederick Law Olmstead, as the first formulator of the concept. Olmstead is quoted as writing in 1921:

> "productive occupations may be roughly divided into those which can be called primary, such as carrying on the marine shipping business of the port and manufacturing goods for general use (i.e., not confined to use within the community itself), and those occupations which may be called ancillary, such as are devoted directly or indirectly to the service and convenience of the people engaged in the primary occupations."

Also in 1921, according to Blumenfeld (13, p. 115), a Mr. M. Auronsseau wrote:

> "The primary occupations are those concerned with the functions of the town. The secondary occupations are those concerned with the maintenance of the well-being of the people engaged in those of primary nature. The more primary citizens there are, the more secondary in a relation something like compound interest."

In the 1930's Homer Hoyt, principal housing economist of the Federal Housing Administration, described the economic base concept as one of the concepts which could be useful in attempts to forecast growth patterns of cities. In a book co-authored with Arthur Weimer (51, p. 32) he stated:

> "A particular city must be able to command a stream of income from beyond its borders if it is to be founded at all. In other words,

> some division of labor between city and country or between one city and another must exist. The fact that the existence of the city seems in a peculiar way to depend upon these outside sources of income has led some writers to designate these as the basic income sources."

The implication is made that those activities which produce the inflow of income are basic to the city. Weimer and Hoyt describe the persons who work in the export activities as town builders. Those who work in occupations that serve the needs of the builders are described as town-fillers.

A 1938 Fortune magazine survey of the economic structure of Oskaloosa, Iowa in a balance of payments framework is credited by Richard Andrews (8, p. 164) as being one of the first empirical efforts to measure the economic base of a community. This survey attempted, among other things to distinguish the "growth" and "service" factors.

B. Terminology

From the very beginning of the use of the base concept a variety of terminology has been used to describe the dichotomy of activities. Terms which have been used as synonymous with basic are: primary, city-building, export, growth sector, active, urban growth and autonomous. Terms which have been used as synonymous with non-basic are: secondary, ancillary, city-filling, auxiliary, domestic, residentiary, service, passive, adaptive, urban-serving and dependent. This proliferation of terms is not necessarily damaging so long as when any two, one from each set, are presented together there is no confusion as to which represents the basic and which represents the non-basic category. Some of the terms have also been used in other contexts so that the use of these terms alone does not unambiguously identify the economic base concept as being in consideration. This is especially the case with the terms "primary" and "secondary" which have been used in the "primary-secondary-tertiary" classification system related to stages of growth.

C. Economic Base Models

1. Early descriptions

Early writers used narrative methods in outlining their concepts and in some cases the functional relationships between total activity, basic activity and non-basic activity are not entirely clear. The arena of action is usually some defined geographical area. The sum of basic activity and non-basic activity is equal to total activity. The basic activity is assumed to be exogenously determined, and the non-basic activity bears some functional relationship to the basic activity. In mathematical notation we may summarize the models of the early thinkers as follows:

Let T = total activity,

B = basic activity and

N = non-basic activity

Then $T = B + N$ and (1)

$N = N(B)$. (2)

By substituting Equation 2 into Equation 1 we obtain:

$$T = B + N(B). \tag{3}$$

Equation 3 states that total activity is entirely a function of basic activity. If the functional relationship of Equation 2 is either relatively stable or changes predictably over time, then Equation 3 can be used to predict future total activity that will be associated with a future level of basic activity. Planners and others who had need for future employment and population estimates were naturally attracted by a concept and a tool which appeared to reduce the number of exogenously determined values required for a solution.

2. Tiebout variation

In the mid-1950's, Charles Tiebout (38) presented a slightly revised model which was more in tune with the economic theory of the day. He was also one of the first to present economic base theory in a precise mathematical formulation. Using the same notation as before, the simple Tiebout model can also be stated in three equations:

Let $T = B + N$ and (4)

$N = N(T).$ (5)

Then $T = B + N(T).$ (6)

Tiebout suggested that income was the unit to use in measuring total, basic and non-basic activities. His model is analagous to the simple Keynesian income determination model. The difference between the Tiebout model and previous models can be seen by comparing Equation 5 with Equation 2.

Equation 5, the Tiebout formulation, says that non-basic income is a function of total income. The relationship might be stated in employment terms, as saying that non-basic employment exists to serve both basic employment and itself. Equation 2 says that non-basic activity is a function of basic activity. In employment terms, Equation 2 implies that non-basic employment exists to serve basic employment only. Equation 2 is analagous to a statement that consumption is a function of investment rather than of total income in the Keynesian income model.

3. Reconciliation of Tiebout and early Models

The two economic base models are equivalent in the sense that they can produce identical results when used to predict an increment of total activity that will be associated with an increment of basic activity. This is a multiplier type problem and can be illustrated with calculus tools.

By differentiating Equation 3 with respect to B we obtain

$$\frac{dT}{dB} = 1 + \frac{dN}{dB}. \tag{7}$$

When Equation 6 is differentiated with respect to B the solution is $\frac{dT}{dB} = \frac{1}{1 - \frac{dN}{dT}}$. (8)

To determine under what conditions the two solutions are identical, we equate the right hand side of Equation 7 to the right hand side of Equation 8; or in symbols, $1 + \frac{dN}{dB} = \frac{1}{1 - \frac{dN}{dT}}$.

The equality will hold provided that $\frac{dN}{dT} = \frac{\frac{dN}{dB}}{1 + \frac{dN}{dB}}$. (9)

Alternatively, we may say that if either $\frac{dN}{dB}$ or $\frac{dN}{dT}$ is given, the value of the other is fixed by the relationship of Equation 9.

The demonstration of the equivalence of the two economic base models may appear to be trivial. However, much of the disagreement surrounding economic base theory is characterized by imprecise descriptions of functional relationships involving an uncertain number of variables. The mathematical models may serve as a framework for sorting out the problems that have appeared and the answers that have been proposed.

4. Complications added to the models

The models become more complicated when basic activity is divided into two or more types and the types are assumed to have differential effects in generating non-basic activity. An example of such a model is the following:

B_1 = basic activity of type 1,

B_2 = basic activity of type 2,

N_1 = non-basic activity associated with type 1 basic activity,

N_2 = non-basic activity associated with type 2 basic activity

T = total activity,

N_3 = non-basic activity associated with total activity,

$$T = B_1 + B_2 + N_1 + N_2 + N_3, \tag{10}$$

$$N_1 = N_1(B_1), \tag{11}$$

$$N_2 = N_2(B_2), \tag{12}$$

$$N_3 = N_3(T) \text{ and} \tag{13}$$

$$T = B_1 + B_2 + N_1(B_1) + N_2(B_2) + N_3(T). \tag{14}$$

The type of multiplier that is generated by this model can be illustrated by differentiating Equation 14 with respect to B_1.

$$\frac{dT}{dB_1} = 1 + \frac{dN_1}{dB_1} + \frac{dN_3}{dT}\frac{dT}{dB_1},$$

$$\frac{dT}{dB_1}\left(1 - \frac{dN_3}{dT}\right) = 1 + \frac{dN_1}{dB_1},$$

$$\frac{dT}{dB_1} = \frac{1 + \frac{dN_1}{dB_1}}{1 - \frac{dN_3}{dT}}. \tag{15}$$

The model represented by Equation 14 and Multiplier 15 has the capacity to treat separately the effects of different types of basic activity. In addition, it can handle another effect which is associated with total activity. This latter effect might be related to the household's portion of the economy and would represent consumption purchases in the area. In such a context households are treated as being homogeneous in their demand characteristics throughout the area. At the same time it is possible with two types of basic activity to allow for dissimilar demand characteristics among firms at least in regard to the basic activities in which the firms are engaged. The model just discussed is conceptually somewhere between the simple Tiebout model and a relatively disaggregated model which will be presented later.

The simplest economic base models have three variables: total activity, basic activity, and non-basic activity. The model builders and their critics have usually discussed subsets of one or more of these variables, but these subsets were not explicitly introduced into the models.

One of the subset systems consists of the division of total activity into two sectors. A sector consists of all firms of an economy which are engaged in similar activities. If the similarity is assumed to be complete, then the firms are assumed to produce identical products from identical inputs using identical technology.

Sector breakdowns were used early in the empirical applications of the simple base models. Weimer and Hoyt (52, p. 108) presented a 1940 classification of employed persons of the New York region classified by basic and non-basic activity and also by thirteen sectors of employment. However, the sector breakdown was apparently used primarily to facilitate the task of differentiating between basic and non-basic employment by individually analyzing portions of the total employment. The sectoral basic and non-basic magnitudes were aggregated respectively into regional basic and non-basic totals. The ratio between the regional totals and the percentage contribution of each sector to total basic employment seemed to be of more interest than any relationship among or within sectors.

M. C. Daly (14) in 1940 used industries and industry groups in analyzing basic and non-basic patterns of employment in areas of Great Britain. In this study also, the industry breakdown served as a vehicle for dividing total employment into basic and non-basic categories. Apparently entire industries were assigned to either one or the other of the two activity categories. The implied model was again the simple one of Equation 16.

The introduction of sector subsets into the thinking of empirically oriented economic base investigators undoubtedly occurred because of the availability of census data disaggregated by sectors. The first crude estimates of economic base ratios were made by assigning some sectors entirely to the basic category and others entirely to the non-basic category.

Later, when surveys were made to determine the basic and non-basic activity on an individual firm basis, the information was summarized by sectors. These surveys universally indicated that each sector had both basic and non-basic activity. The results which appeared to be of most interest were those showing what percent of each sector's activity was basic and what percent each sector's basic activity was of total basic activity.

A consequence of the disaggregation by sectors is that it becomes conceptually difficult to relate any part of non-basic activity exclusively to a part of basic activity as was done in Equations 11 and 12. A portion of a sector's output which is exported (i.e., basic) is by assumption not distinguishable from that portion which is used within the area (i.e., non-basic). The associated activity demanded of various sectors by the basic activity is therefore no different proportionately than that demanded by the non-basic activity. The demands of firms for inputs may differ among sectors but do not differ between the basic and non-basic parts of a sector. This conceptual interpretation is analagous to the simple Tiebout model of Equations 4 through 6 which related total non-basic activity to total overall activity.

Demand by households can be treated as uniform over all households as was done in the model of Equation 14. Alternatively, where disaggregation by sectors is used, some or all of the households may be identified with particular sectors, usually by attaching each household to the sector in which the wage-earner is employed. This classification of households is conceptually desirable if households so attached to different sectors are thought to differ appreciably in spending levels and patterns. In a following model household purchases are designated as final consumption activity and each sector is permitted to exhibit a unique consumption activity pattern.

5. Criticisms of economic base theory

One of the potentially most telling criticisms of both the simple and the more sophisticated economic base theories is that basic activities are in no sense more "basic" than the non-basic ones. Blumenfeld (13, p. 116) has expressed this view and drawn in outside opinion to support his statement.

> "...The literature on the subject is pervaded by a conviction that the "basic" activities are more important than the "non-basic" ones. ...This is evidently untrue. No "basic" industry in a modern city could function without such services as water, transportation, and communication. Some students of the subject are aware of this. "Urban-Growth and Urban-Serving Employment...are both equally essential," says Victor Roterus; and the U. S. Chamber of Commerce speaks of "a chicken-and-egg relationship," adding: "industrial growth stimulates the remainder of the local economy and the existence of the community makes possible industrial growth."

Homer Hoyt (21, p. 53) has responded to the criticism of Blumenfeld with a fairly strong defense of the economic base concept, at least insofar as the economic base is equated with export activity.

> "The plain simple principles of the economic base have been obscured by such statements as: "the distinction between basic and non-basic seems to dissolve in thin air" and that non-basic activities are the permanent and constant element in the metropolitan area economy...There is abundant evidence that the growth of most American cities in recent decades has been the direct result of the increase in basic employment. Examples can easily be cited of this relationship between basic employment and population of urban regions in the 1950-1960 decade."

In essence, Blumenfeld implied that export employment is a function of domestic employment while Hoyt maintains that domestic employment is a function of export employment. If either is true, it is not likely that a simple analysis of census data would provide evidence for rejection of the other concept. The numbers would be the same in either case unless a discernable lag was involved in the functional relationship, and observations at a minimum of three points in time with at least two periods of unequal growth rates involved would be needed to identify the lag and the direction of causality. Even with such observations it would be necessary to assume that no change in the underlying basic and non-basic ratio was occurring over time or, if it were changing, that its value at each point in time is known.

There is even a third theoretical alternative. Basic and non-basic activities may be interdependent. In this case neither activity can be said to be a simple function of the other. The most that can be said is that the values of the two variables are positively correlated. Nevertheless, the observed behavior of the correlated variables would be identical to that in a situation where either one was autonomous and the other a function of the autonomous one.

Tiebout (37, pp. 163-164) has made a compelling case for a theory of inter-dependence in an article where he warned against the over-simplification involved in the export base concept.

> "It is possible to define the necessary condition for regional economic growth as the creation of an export base. But location theory, which is called on to explain its creation will work only if factor costs are known. The determination of factor costs depends in part on the nature of the region's residentiary activities."

In the final analysis the export concept seems to draw intuitive support because it is possible to visualize an area that engages entirely in export activity and imports all its residentiary goods and services. However, an area which engages entirely in residentiary activities cannot exist unless its residents are willing to live without imports. Imports must be paid for with money earned from exports. Hence, in a crude reasoning sequence, (1) export activity could exist alone and can thus be considered autonomous, (2) residentiary activity supplemented by imports cannot exist unless export activity produces a money inflow, (3) therefore, residentiary activity is dependent on export activity.

This reasoning is most applicable in very small areas where a very large part of the goods and services wanted cannot be efficiently produced by residentiary activity. As the area under consideration becomes progressively larger, the possibility of import substitution becomes progressively greater until at the limit no imports are needed and the export base can disappear. Many of the protests against over-use of the economic base concept were apparently motivated by the application of the concept to increasingly larger areas.

A more basic source of disagreement is the fact that the use of the term, "economic base theory", has not been restricted to any precisely defined model. The early developers had a model with institutional and operational variables such as areas, exports, imports, firms, and households. Economic activities were generally restricted to exporting and importing although production and absorption of products were, in most cases, implied.

The causal relationship between exporting and production in the area was assumed to be empirically obvious. Little effort was made to relate the model to the more abstract economic concepts such as aggregate supply, aggregate demand, area income, area output, area expenditure, consumption, savings and investment. Even less effort was made to relate to international trade theory concepts of comparative advantage, foreign trade multipliers, balance of payments equilibrium and exchange rates. Almost no effort was made, or has been made to date, to relate to growth theory for which an assumed production function of some kind is required. As economists, particularly those with more recent training, began working with economic base theory they tended to object to solutions which did not depend on or have any assumptions with respect to consumption functions, changes in net investment, income multipliers and other concepts which are basic in economic theory.

A general disaggregated model notation to be described next is consistent with operational (i.e., easily measurable) variables. However, at a later point the variables in this model are assembled in combinations which approximate the more abstract variables of macroeconomics. Further discussion of the insights revealed by such merging attempts is deferred until that point.

6. Notation for a general disaggregated model

The notation for a general disaggregated model employs the capital letter "V" for all variables and appropriate subscripts to distinguish among variables. The letter "V" is intended to indicate transactions activity in terms of value-added contributed by factors employed in the supplying sector. The degree of disaggregation must be sufficient to specify the sector and area supplying an increment of value-added, the sector and area receiving an increment of value-added and the type of economic unit within the sector receiving the value-added. Such information requirements can be presented in a four position subscript, as follows:

V_{ijkl} = the general notation for specific transactions for which the subscript positions and range of values mean the following:

i = "area from" and "area to" designation.

= m, for imports, *i.e.*, only transfers of value-added where the supplying sector is outside the studied area and the receiving sector is in the studied area are included in the magnitude of V_{mjkl}.

= e, for exports, i.e., only transfers of value-added where the supplying sector is in the studied area and the receiving sector is outside the studied area are included in the magnitude of V_{ejkl}.

= a, for intra-area transfers, i.e., only transfers of value-added where both the supplying sector and the receiving sector are within the studied area are included in the magnitude of V_{ajkl}.

= o, for extra-area transfers, i.e., only transfers of value-added where both the supplying sector and the receiving sector are outside the studied area are included in the magnitude of V_{ojkl}.

= d, for the sum of export transfers and intra-area transfers demanded, i.e., $V_{djkl} = V_{ejkl} + V_{ajkl}$.

= s, for the sum of import transfers and intra-area transfers supplied, i.e., $V_{sjkl} = V_{mjkl} + V_{ajkl}$.

= t, where no restriction on area of origin or area of destination are imposed. All transfers of value-added which are not restricted by other postscript designations are included in the magnitude of V_{tjkl}.

j = supplying sector designation.

= 1, 2, ..., n for numbered sectors

= t, where no restriction on sector of origin is imposed. All transfers of value-added which are not restricted by other postscript designations are included in V_{itkl}.

k = sector supplied (sector receiving) designation.

= 1, 2, ..., n for numbered sectors.

= t, where no restrictions on sectors of designation are imposed. All transfers of value-added which are not restricted by other postscript designations are included in V_{ijtl}.

l = receiving economic unit designation.

= h, where receiving units within receiving sectors are restricted to households.

= f, where receiving units within receiving sectors are restricted to firms.

= t, where no restriction is placed on the type of receiving unit. All transfers of value-added which are not restricted by other postscript designations are included in V_{ijkt}.

In a model with two sectors the following symbols illustrate total economic activity and some of the possible disaggregations.

V_{tttt} = total of value-added for the world. This is equivalent to total output which in turn can be considered equivalent to total income and total expenditure.

V_{attt} = total of value-added produced in the area which is transferred to sectors of the area.

V_{ettt} = total of value-added produced in the area which is transferred to sectors outside the area.

$V_{attt} + V_{ettt}$ = total of all value-added produced in the area.

V_{mttt} = total of value-added produced outside the area which is transferred to sectors in the area.

$V_{mttt} + V_{attt}$ = total of all value-added received by all sectors of the area.

V_{e1tt} = total of value-added produced by sector 1 of the area which is transferred (exported) to all sectors outside the area.

V_{a12h} = total of value-added produced by sector 1 of the area which is transferred to area sector 2 households.

The earliest models, including those of Olmstead, Aurousseau, and Hoyt, can be put into the sector and subscript notation as follows:

$$V_{dttt} = V_{ettt} + V_{attt} \tag{16}$$

Equation 16 states that total activity is the sum of basic activity and non-basic activity.

$$\frac{V_{attt}}{V_{ettt}} = K, \tag{17}$$

where K is a constant applicable to the particular city or area being described. Equation 17 describes a linear functional relationship between basic activity and non-basic activity. In words, non-basic activity is K times basic activity.

If Equation 17 holds, then it can be shown that a functional relationship also exists between total activity and non-basic activity. Equation 16 is divided through by V_{attt} yielding

$$\frac{V_{dttt}}{V_{attt}} = \frac{V_{ettt}}{V_{attt}} + \frac{V_{attt}}{V_{attt}}$$

$$= \frac{1}{K} + 1$$

$$V_{attt} = \frac{K}{1 + K} \cdot V_{dttt}.$$

In words, non-basic activity is $\frac{K}{1 + K}$ times total activity.

7. Measurement and interpretation differences

Other concerns about the economic base concept have generated two additional types of disagreements. One relates to the appropriate unit to use in measuring economic activity. The other is concerned with the appropriate disaggregation needed to refine the model. Tiebout (38) has argued for the use of income accruing to residents as the measuring unit. With income as a unit it is almost inevitable that economists would want to look at consumption activities separately because of their training in consumption function theory.

The variable, V_{atth} (non-basic activity demanded by area households activity), became important as a separate entity in the analysis of area economic activity. Implicitly, another variable, the residual of non-basic activity, was thus created and is represented in subscript notation by V_{attf} (non-basic activity demanded by area firms activity).

The use of income as a unit has also led to the suggestion that since earnings per worker varies by industrial sector of employment, as shown particularly by Perloff (31, pp. 520-535), consumption patterns should also be considered separately by sectors. Accordingly, the V_{atth} variable should by this way of thinking be disaggregated into V_{at1h}, V_{at2h}, ..., V_{atnh}.

Charles Leven (26) proposed "value added in the area" as the proper unit of measurement in base oriented studies. An important reason for his espousal of the "value-added" unit was the ambiguity that had crept into economic base thinking with the recognition of "indirect export" activity. Leven (26, p. 370) illustrated indirect export activity with the following example:

> "Suppose there is an area which has two canneries producing canned foods all of which are sold outside the area. Further, suppose that the first cannery prints its own labels, while the second purchases them from a local printer. For the sake of simplicity, it will be assumed that the printer sells all of his output to the second cannery. It seems fair to assert that the employees of the print shop are just as much export employees as the workers in the label shop of the first cannery."

The employees of the independent print shop are the ones who would be classified as indirect export employees if a survey were to be conducted in the area and as such would become part of the non-basic activity total (if employment were the unit of measurement). Leven argued that a "value-added in the area" unit would automatically include the output of workers contributing to direct export sales and the output of those whose products entered only indirectly into exports after one or more intervening sales within the area. This is so because, in the absence of subsidies, the sale price of exports must in the long run include the cost of all inputs both those originating within the area and those imported from outside. If the cost of imports is somehow determined and deducted, the residual is the value added within the area both directly and indirectly.

The emphasis thrown upon the contribution of indirect export activity and particularly upon the possibility of variability of this contribution created the opportunity for further disaggregation of the variables in the model. It could now be considered helpful to disaggregate V_{attf}, non-basic activity supplied to area firms activity. It seemed probably that the demands by firms of the sectors might be different, and V_{at1f}, V_{at2f}, ..., V_{atnf} were therefore reasonable variables for consideration. Even further disaggregation could be considered if the production demands by firms of each of the sectors on each of the other sectors including itself were thought to be important for the analysis. Each variable then would be specific as to sector of origin and sector of destination of the goods or services of the non-basic activity.

Some further reflection of the degree of disaggregation up to this point will reveal that the demands generated by firms' activities are fully disaggregated by sector supplying, type of activity, sector supplied, and demand type. Since consumption activities have also been given a prominent place in the model, it would seem reasonable to disaggregate just as fully the demands generated by households. If this is done, the model will have reached the degree of disaggregation permitted by the sector and subscript notation system that has been used.

It is at this point that emphasis must shift to the input-output approach which developed apart from the economic base theory, but is nevertheless closely allied to it in concept and is admirably suited to handle the degree of disaggregation of variables which has been described.

8. Input-output models

Formal presentations of input-output technique are available in a number of mathematical and economics publications. Some familiarity with linear algebra techniques and with matrix notation is essential for understanding the full range of potentialities and problems involved in input-output analysis. In this portion of the study the description of one type of input-output model is attempted by the presentation of examples. The implied economic assumptions are illustrated and discussed insofar as seems practical for our purpose. Mathematical properties and subtleties are not stressed except as they limit or proscribe the type of economic assumptions in order to permit a solution.

Using the same notation as before, the transactions relationships of an area with three sectors can be described in the following equations:

$$V_{a11t} + V_{a12t} + V_{a13t} + V_{e1tt} = V_{d1tt} \qquad (18)$$

$$V_{a21t} + V_{a22t} + V_{a23t} + V_{e2tt} = V_{d2tt} \qquad (19)$$

$$V_{a31t} + V_{a32t} + V_{a33t} + V_{e3tt} = V_{d3tt} \qquad (20)$$

Equations 18, 19, and 20 each show that the total output of a sector (the right-hand term of each equation) is made up of the demands of all of the sectors in the area for this output (the first three terms of each equation) plus the demand from export sources for this output (the last term of the left-hand side of each equation). The non-basic variables are not fully disaggregated in this example since the firms and households demand of each sector is combined. This combination at this point is primarily for simplification purposes in illustrating the working of the input-output model with the minimum number of variables.

A hypothetical survey of an area for the three sector model might generate relationships such as the following for the three transactions equations:

$$100 + 200 + 600 + 9{,}100 = 10{,}000 \tag{18'}$$

$$300 + 200 + 600 + 8{,}900 = 10{,}000 \tag{19'}$$

$$5{,}200 + 4{,}500 + 14{,}400 + 5{,}900 = 30{,}000 \tag{20'}$$

Each of the entries in Equations 18', 19', and 20' corresponds exactly to the corresponding entries in the Equations 18, 19, and 20. The measure of economic activity in the numerical equations is presumed to be employment or some other magnitude for each sector divided into a number of units equal to the employment of the sector. Equations 18', 19', and 20' then describe an area with total employment of 50,000, export employment of 23,900 and residentiary employment of 26,100. Total employment is given by the sum of the right-hand side terms of the equations, export employment by the sum of the last terms of the left-hand side of the equations, and residentiary employment by the sum of the remaining terms of the equations.

The transactions equations provide the basic data for the creation of an input-output framework. The next step is the creation of ratios which relate the total employment of each sector to the demands it makes on each sector including itself. One of the ratios needed is V_{a12t}/V_{d2tt}. From the numerical example this would be $200/10{,}000 = 0.02$. This ratio states that for every sector 2 employee in the area, 0.02 of a sector 1 employee is engaged in filling local demand generated by sector 2 activity.

The process of computing all the required ratios is conveniently illustrated by matrix algebra notation. One matrix is formed by the first three terms of each of the structural equations. This matrix is post-multiplied by a diagonal matrix formed by the reciprocals of V_{d1tt}, V_{d2tt} and V_{d3tt}.

$$\begin{bmatrix} V_{a11t} & V_{a12t} & V_{a13t} \\ V_{a21t} & V_{a22t} & V_{a23t} \\ V_{a31t} & V_{a32t} & V_{a33t} \end{bmatrix} \quad \begin{bmatrix} 1/V_{d1tt} & 0 & 0 \\ 0 & 1/V_{d2tt} & 0 \\ 0 & 0 & 1/V_{d3tt} \end{bmatrix}$$

This multiplcation results in:

$$\begin{bmatrix} V_{a11t}/V_{d1tt} & V_{a12t}/V_{d2tt} & V_{a13t}/V_{d3tt} \\ V_{a21t}/V_{d1tt} & V_{a22t}/V_{d2tt} & V_{a23t}/V_{d3tt} \\ V_{a21t}/V_{d1tt} & V_{a32t}/V_{d2tt} & V_{a33t}/V_{d3tt} \end{bmatrix}$$

All of the required ratios have been formed. The matrix of the ratios becomes a part of what is usually termed the Leontief technology matrix of input-output analysis.

By running the numerical example through the matrix operations the following technology matrix is produced:

$$\begin{bmatrix} .01 & .02 & .02 \\ .03 & .02 & .02 \\ .52 & .45 & .48 \end{bmatrix}$$

Ratios such as those derived above might be interpreted as nothing more than quotients which describe an input-output relationship that happened to exist during one period of time. However, in input-output analysis the ratios have additional meaning. The economic assumption is made that the ratios are fixed either over time or over a range of output or both. This assumption in effect makes the ratios the fixed quantities in a production function so that if the amount of output is known the amount of each input required is uniquely determined. The fixed ratios are usually called fixed production coefficients. A set of ratios linking an output with each of the required inputs is sufficient to describe a process. Within the process there is no possibility of substitution among factors. Only if different processes are available for producing the same output is there anything comparable to the continuous factor substitution usually assumed in the traditional production function.

Input-output analysis gained prominence through Wassily Leontief's attempts (24; 25, pp. 11-65) to describe the productive structure of the entire American economy. In its basic form, the Leontief system relies on the fixed coefficient type of production function. While the possibility of the existence of many possible processes was recognized there was generally no use of this possibility in the analysis.

The assuming away of the possibility of substitution among factors is done primarily in order to keep the mathematical burden within reason. However, some rationalization for this assumption is provided by an attempt to logically limit the variation of relative prices of labor and capital. The argument is that since labor is by far the largest cost in producing capital goods the price of the latter will maintain a fairly constant relationship to the price of labor.

An extension of the argument is that at any one time a "best-practice" technique will exist in any production process, and it will be that which uses the minimum amount of labor per unit of output, counting both direct and congealed labor.

Economies of scale as a phenomenon permitting variation of coefficients among firms of different sizes are ignored by assuming that competitive forces have eliminated those firms too small to capture full economies of scale.

The assumption of constancy of the input-output ratios transforms the technology matrix into a mathematical entity which can be used to compute total activity for each sector, when export activity for each sector, is known. Alternately, if total activity by sectors is known, then export activity by sectors can be derived. Residentiary or non-basic activity can be derived as a residual in either case. Thus the input-output framework is closely analagous to the economic base formulation with the added advantage of possessing a more systematic system for handling disaggregated variables.

D. Economic Base Analysis and Economic Theory

1. General economic models and economic base theory

An area economy that engages in trade with the outside world can be represented by the following macroeconomic model;

$$Y = C + I + E - M$$

in which the symbols may be interpreted as follows:

Y = Income (return to factors of production of the area)

= Output (value-added produced in the area)

= Expenditure (for value-added produced in the area).

C = Consumption Expenditures (purchase by area households of consumption products from area firms).

I = Investment Expenditures (purchase by area firms of investment products from area firms or factor owners in excess of amounts needed to replace capital depreciation and inventory decline).

E = Export Expenditures (purchase by out-of-area buyers of products from area firms or labor services of area households).

M = Import Expenditures (purchase by area buyers of products of out-of-area firms or labor services of out-of-area households).

Consumption products are those for which the use after the final sale in the time period considered is consumption.

Investment products are those for which the use after the final sale in the time period considered is investment.

A large number of transactions can occur among firms of the area in which the product is intermediate in the sense that it will be incorporated in some way into the final product of the buying firm. The final sale of a product into consumption, investment or export uses is assumed to be for a price that will include all increments of value added that were contributed at initial and intermediate stages of production. Therefore, the firm-to-firm sales of intermediate goods must be eliminated from the grand total of expenditures in the area. In principle, this could be shown in the macroeconomic model by adding in the sum of expenditures of area firms to area firms and subtracting out the sum of total receipts of area firms from area firms. This point concerning the handling of intermediate sales will assume some importance in the attempt to reconcile economic base concepts with macroeconomic theory.

The macroeconomic model must have some behaviorial assumptions if it is to be more than a simple balance equation. Following simple Keynesian theory, we may assume that consumption is a function of income. This assumption may be expressed in symbols as

$$C = C(Y).$$

A part of gross investment may also be a function of income, or of output which is a counterpart of income. This part would be that new investment needed to replace capital depreciation and sales from inventory. However, that part of new investment which represents additional capital accumulation or increases in inventory is more reasonably related to entrepreneurs' expectations of future demands for output. Therefore, in the static model, the net investment term, I, is usually assumed to be exogenously determined in the sense that expectations are not a function solely of any one or all of the variables of the model. Most of the simpler economic base models have ignored net investment as a final demand. If it were a function of output, it would properly be a part of non-basic activity. If it were independent of the other variables, it would be as much a part of basic activity, at least in the short run, as is export activity. It is possible that net investment could equal zero while at the same time output and exports could increase through technological change or through an influx of labor, or through imports of finished capital goods. Therefore, a model which ignores net investment is not necessarily wrong, but it might be considered incomplete by a seasoned macroeconomist.

Imports, M, are usually considered to be a function of income and the relationship could be designated in a manner equivalent to the consumption function designation. However, while consumption is, in all general contexts, thought to be a direct function of income, there is some ambiguity involved in the import and income relationship. In the short-term, Keynesian, monetary demand type of analysis the correlation between imports demanded and area income is usually assumed to be positive on the average and at the margin. In the long-term, growth context, real demand type of analysis a larger output and income implies a larger economy which can provide local markets of a sufficient minimum size for a greater number of local products so that demand for imports might shift sufficiently to cause an absolute decline of imports. A crucial difference in the models resides in the assumption regarding population growth. The short-term model user usually assumes a stable population so that an absolute income increase produces an equivalent per capita income increase. The growth model user usually assumes a growth in factors of production, including labor and thereby population, so that per capita income increase is not proportionately as great as absolute income increase. The distinction between per capita income increase effects and total income increase effects was not well covered by Tiebout when he first championed income as an appropriate export base unit. However, he covered this omission admirably in a later contribution (36).

For the moment it will be assumed that the propensity to import is positive with respect to income and output changes in a function that is assumed to describe areas of the United States. This qualitative assumption is probably realistic, and it will simplify matters during a following discussion of the possible determinants of export levels.

2. Cumulative and non-cumulative measurements

A short discussion of cumulative versus non-cumulative economic measurement systems is helpful as a prelude to a reconciliation of an economic base model with a traditional macroeconomic model. The notational system previously outlined is designed to be used as a non-cumulative system. The variable, V_{a42h}, for example, describes a relatively isolated increment of value added. It is the value-added produced in sector 4 of the area which was transferred (sold) to households of sector 2 of the area. Households, however, did not buy this increment of value-added in isolation. The value-added was imbedded in a set of products which had been "built up" into its final form by a succession of value-added incremental additions contributed by several sectors of the economy including imports from outside the area.

The total value of this set of products may be assumed to be represented by the sum of the sales of area sector 4 firms to area sector 2 households. This assumption implies that, for each product, the total of the value-added increments is the determinant of the market price. Sales data is, therefore, an example of a cumulative economic measurement system. In principle, final sales data for an area, i.e., sales to consumption, net investment and export, includes the imported value-added and the value-added produced by intermediate and final production in the area.

To construct an equivalent value from the non-cumulative system it is necessary to sum the following:

V_{mtth} = that imported value-added which is purchased for final use by area households.

V_{mttf} = that imported value-added which is purchased for intermediate use by firms but destined for final use. The final use may be either consumption, net investment, or export.

V_{atth} = that area produced value-added which is purchased for final use by area households.

V_{attf} = that area produced value-added which is purchased for intermediate use by area firms but destined for final use of consumption, net investment or export.

V_{ettt} = that area produced value-added which is purchased for final use as exports by out-of-area firms and/or households.

To adapt the above notation to a macroeconomic framework, it is necessary to find combinations of the above variables which can correspond to the concepts of consumption, investment, exports, imports, and total income or total output. The goal is to put the above variables into the standard equation

$Y = C + I + E - M.$

Imports may be designated as $V_{mtth} + V_{mttf}$. If import movements across an area's border were actually measured, the latter two magnitudes could be determined if the value and recipient of each product were determined. If the recipient is a household, the value of the product is included in V_{mtth}, and we may reasonably classify all of V_{mtth} as a part of consumption. Such a classification implies that households do not resell any of their purchases to firms or to export, and that they are not engaging in any net additions to housing in which household purchased imports appear.

If the recipient of an import is a firm, the value of the product is included in V_{mttf}. At this point the product is simply an intermediate good, and all of V_{mttf} must be initially considered as intermediate product. The value of V_{mttf} is eventually divided into one or more of the final uses, but at the border there is no way to determine what the particular division pattern of any one product will be. Thus, there is no way to determine empirically what the division pattern of V_{mttf} as a whole will be.

Another part of consumption is made up of purchases by households of value-added produced in the area. This magnitude is given by V_{atth} which may, therefore, be treated entirely as a part of consumption.

Area produced value-added which is purchased by area firms, V_{attf}, is like V_{mttf}, initially considered only as intermediate value-added. This value will also ultimately be divided into one or more of the final uses although the division pattern cannot be determined empirically.

The export variable, V_{ettt}, can be classified entirely as a part of exports, but it represents only the value-added that was both produced in the area and sold directly to outside buyers. The products in which this value-added was embedded have additional increments of value which originated in imports by area firms and in intermediate products production by area firms.

There is no variable in the notation system which can be treated entirely as a part of investment. Investment, defined as net capital additions, is measurable only as a difference between capital inventory at the end of a period of time and capital inventory at the beginning of that period of time. No particular product is an investment product, but the total of all firm-owned products at the end of a period may be partly investment to the extent that this total exceeds the beginning total. For the present it is convenient to assume that investment is zero and that any products that might be called investment goods are simply replacing the depreciation of capital stock and depletion of inventories which occurred during the production and sale of consumption and export products. The value-added involved in the replacement of capital depreciation and inventory depletion must, therefore, be charged to consumption and export.

Consumption can now be designated as the sum of (1) household purchases from outside the area, (2) that area produced value-added which is purchased for final use by area households, (3) an undetermined proportion, (P_{mc}), of the purchases of area firms from outside the area, (4) an undetermined proportion (P_{ac}) of that area produced value-added which is purchased for intermediate use by area firms. The sum can be shown in an equation in which the variables appear in the same order as listed above.

$$C = V_{mtth} + V_{atth} + P_{mc}V_{mttf} + P_{ac}V_{mttf}$$

Exports can be defined in an analagous way as the sum of (1) a proportion, (P_{me}), of purchases by firms from outside the area, (2) a proportion, (P_{ae}), of that area produced value-added which is purchased for intermediate use by area firms and (3) that area produced value-added which is purchased for final use by outside firms and households. The equation defining exports is

$$E = P_{me}V_{mttf} + P_{ae}V_{attf} + V_{ettt}$$

We require of the proportions that

$P_{mc} + P_{me} = 1$ and

$P_{ac} + P_{ae} = 1$

so that imports and area produced intermediate products will be exhausted into final uses.

Consumption and export have been defined in the economic base notation. Investment has been assumed away so no definition is required for it at this point. Imports are defined rather simply as the sum of import purchases by area households and import purchases by area firms, or in symbolic notation as $M = V_{mtth} + V_{mttf}$.

Conceptually, the connection between the economic base notational system and a simple macroeconomic model has been completed. The connection may, in a sense, be checked by writing the equation $Y = C + E - M$ and substituting in the economic base equations for C, E, and M. The result, after cancellations and simplification, is

$$Y = V_{atth} + V_{attf} + V_{ettt}$$

$$= V_{attt} + V_{ettt}$$

This result agrees with the definition of Y at the beginning of the economic base notational system.

3. International trade theory and economic base theory

Economic base theory has usually ignored the outside area or world with which trading is conducted. This is somewhat surprising since international trade theory has for a long time been developed to include the analysis of reciprocal effects. The analysis and comments which follow immediately are based largely on international trade models which have been presented by Vanek (50, pp. 106-109).

The key point underlying the generation of reciprocal effects is to note that, in the two area case, the imports of one area are the exports of the other area. If imports are a function of the income of the importing area, then exports of one area must be a function of the income of the other area. The basic income identities of the two areas may be written as:

$$Y_1 = C_1(Y_1) + I_1 + M_2(Y_2) - M_1(Y_1) + A \text{ and}$$

$$Y_2 = C_2(Y_2) + I_2 + M_1(Y_1) - M_2(Y_2) - bA$$

where the numerical subscripts indicate Area 1 and Area 2. The exports of Area 1 are designated as M_2 since they are identical to the imports of Area 2. Similarly, the exports of Area 2 are designated as M_1.

Symbol A is intended to represent a shift variable which is given a value if we wish to introduce a shock to the system. By convention, we define positive values of A as intended increases in income of Area 1. They may, therefore, alternately represent a parallel upward shift in the consumption function, an increase in investment, an increase in exports or a general increase in output through technological change or an increase in resources. Negative values of A, of course, represent intended decreases of income of Area 1.

If A represents an increase of exports in Area 1, there must be a corresponding increase in imports in Area 2. The import increase represents a reduction of income for Area 2 so that bA (b = 1) must be subtracted from Y_2. When A represents income increases from other than Area 1 exports, there need not necessarily be a direct corresponding effect in Area 2. For these cases the coefficient b is equated to zero.

In order to determine the final income effects of intended changes in Area 1 income we may differentiate the two income identity equations totally with respect to A.

To simplify notation, first partial derivatives of the functions are indicated with primes. Thus, for example, C_1' equals the partial derivative of C_1 with respect to Y_1. The total differentiation results are:

$$\frac{dY_1}{dA} = C_1' \frac{dY_1}{dA} + M_2' \frac{dY_2}{dA} - M_1' \frac{dY_1}{dA} + 1 \text{ and}$$

$$\frac{dY_2}{dA} = C_2' \frac{dY_2}{dA} + M_1' \frac{dY_1}{dA} - M_2' \frac{dY_2}{dA} - b.$$

With some rearranging and the use of matrix notation the above solutions appear as follows:

$$\begin{bmatrix} 1 - C_1' + M_1' & - M_2' \\ - M_1' & 1 - C_2' + M_2' \end{bmatrix} \begin{bmatrix} \frac{dY_1}{dA} \\ \frac{dY_2}{dA} \end{bmatrix} = \begin{bmatrix} 1 \\ -b \end{bmatrix}$$

The general solution, by Cramer's rule, is $\frac{dY_j}{dA} = \frac{D_j}{D}$, where D is the determinant of the coefficient matrix and D_j is the determinant of the same matrix with the jth column replaced by the column of constant terms. The specific solutions for the present case are:

$$\frac{dY_1}{dA} = \frac{1 - C_2' + M_2' - bM_2'}{(1 - C_1' + M_1')\ (1 - C_2' + M_2') - M_1'\ M_2'} \quad \text{and}$$

$$\frac{dY_2}{dA} = \frac{-b\ (1 - C_1' + M_1') + M_1'}{(1 - C_1' + M_1')\ (1 - C_2' + M_2') - M_1'\ M_2'} .$$

Making use of the identity that one minus the marginal propensity to consume is equal to the marginal propensity to save, S_j', we may write, $1 - C_j' = S_j'$.

The denominator of the solution may now be written $(S_1' + M_1')\ (S_2' + M_2') - M_1'\ M_2'$.

The numerator of $\frac{dY_1}{dA}$ is equal to S_2' when $b = 1$. It is equal to $S_2' + M_2'$ when $b = 0$. After some further mathematical simplification, the solutions are

$$\frac{dY_1}{dA}\ (b = 1) = \frac{1}{S_1' + \frac{S_1'}{S_2'} M_2' + M_1'};$$

$$\frac{dY_1}{dA}\ (b = 0) = \frac{1 + \frac{M_2'}{S_2'}}{S_1' + \frac{S_1'}{S_2'} M_2' + M_1'};$$

$$\frac{dY_2}{dA}\ (b = 1) = \frac{-1}{S_2' + \dfrac{S_2'}{S_1'} M_1' + M_2'};$$

$$\frac{dY_2}{dA}\ (b = 0) = \frac{M_1'}{S_1'\ S_2' + S_1'\ M_2' + S_2'\ M_1'}\ .$$

We are primarily interested in using the above multipliers to examine the relationship of a very small area to a very large area in an economic base analysis context. The small area might have a population of 200,000 and the large area a population of 200,000,000, making the comparative size ratio 1 to 1,000.

An extremely simplifying, though perhaps not realistic, aspect of the simple economic base model is the implied absence of a savings function. If export is the only autonomous final demand variable, then autonomous investment must equal zero and, assuming imports equal exports, planned savings must be zero for an equilibrium income position above zero to exist.

The preceding paragraph should not be interpreted to mean that the propensity to save vanishes for both areas. Economic base theory has usually considered only the "home" area and has made no assumptions about the "other" area except to imply that increased exports would somehow be accepted.

An alternate savings-investment assumption which could fit simple economic base models is to assume that investment in the home area is endogenous and is a function of income. In order to maintain equilibrium the savings and investment functions must be identical. If savings and investment are always equal, the marginal propensities to save and invest must be equal. The home area marginal propensity to invest will, under these circumstances, cancel out the home area marginal propensity to save wherever the latter appears in the foreign trade multiplier. The net result on the multipliers of this line of reasoning is the same as with the previous assumption that home area savings are zero.

Let Area 1 be considered the small area at this point. Then S_1' equals zero, but S_2' may have some positive value. The multiplier in the foreign repercussion case (b = 1) reduces to $\frac{dY_1}{dA}(b = 1) = \frac{1}{M_1'}$.

This is the reciprocal of the Area 1 marginal propensity to import. If imports include value-added which is incorporated into exports, the marginal propensity may be greater than 1.0. If imports are counted net of export-destined increments, the marginal propensity will be less than 1.0, perhaps about 0.5.

In the non-repercussion case (b = 0) the multiplier reduces to

$$\frac{dY_1}{dA}(b = 0) = \frac{1 + \frac{M_2'}{S_2'}}{M_1'}$$

The non-repercussion multiplier has an added term in the numerator which would appear to increase the size of the multiplier in comparison with the repercussion case. However, the term, M_2', the propensity of the large area to import from the small area, is likely to be very small, perhaps about 0.0005. The added term in the numerator is, therefore, scarcely above zero, and the non-repercussion multiplier is approximately the same as the repercussion mutliplier.

It is also of interest to observe the case where the shock is administered by the other area. To study this with the help of the multipliers already given, we simply switch area numbers. The small area becomes Area 2, and the large area becomes Area 1. Accordingly, S_2' is now zero. In the case of an autonomous increase in exports by the large area the multiplier becomes $\frac{dY_2}{dA}$ (b = 1) = $\frac{-1}{M_2'}$.

In this case the small area loses income at the same rate as it gained income when it was the export increasing area. A further interpretation can be made if, in differential terms, dA is considered negative. This would correspond to import reduction, sometimes called import substitution, by the small area. The result of this small area import reduction is exactly the same as the result of a small area export increase. This last conclusion can, of course, also be deduced from the original general multipliers.

Another case to be considered is the autonomous large area increase in income by other than increased large area exports. The mutliplier for this is $\frac{dY_2}{dA}$ $(b = 0) = \frac{M_1'}{S_1' \; M_2'}$.

Again a very small value is in the numerator and is the only term there. However, dA in this case is a change in large area income so that we could have a case of a very small multiplier and a very large (in relation to the size of Y_2) multiplicand. Some estimated numbers must be inserted into the multipliers in order to suggest the relative magnitude of change.

Let $Y_{\text{large area}} = 100,000$,

$Y_{\text{small area}} = 100$,

$dA = 10\%$ of corresponding $Y = 10,000$,

$S'_{\text{large area}} = 0.3$,

$M'_{\text{large area}} = 0.0005$ and

$M'_{\text{small area}} = 0.5$.

The values assigned are proportional to area sizes and are made to provide a constant equilibrium by assuming that marginal propensities equal average propensities. The large area was assumed previously to have a population 1,000 times greater than the small area. Large area income is, therefore, 1,000 times small area income. Large area savings propensity does not have to be consistent with any other value so its value of 0.3 is entirely arbitrary. One of the import propensities can be chosen arbitrarily so we assume that the small area propensity is equal to 0.5. The imports of the small area per time period are, therefore, equal to 50. Assuming that exports equal imports, the exports of the small area (imports of the large area) equal 50 also. The propensity to import of the large area is, therefore, 0.0005.

The numerical values can be inserted into the final one of the four simple multipliers. This, it may be recalled, is the case where the large area has an increase in autonomous income other than export income, and the small area is designated as Area 2. The change in income in the small area is

$$dY_2 = \frac{M_1'}{S_1' \; M_2'} \, dA = \frac{0.0005 \times 10,000}{0.3 \times 0.5} = 33.33$$

$$= 33.33\% \text{ of } Y_{\text{small area}}.$$

In spite of the small numerator in the mutliplier, the total effect on Y_2 is substantial. The initial 10 percent increase in large area income has induced a one-third increase in small area income. For the small area a 10 percent income increase occurred through initial export expansion. The balance of the income increase is the result of multiplier effects.

Using the same set of numerical values, it is possible to check out the case where the small area has an autonomous increase in non-export income. The second of the simple multipliers is the appropriate one for this non-repercussion case, and the small area is now again Area 1. The total change in small area income is represented by

$$dY_1 = \frac{1 + \frac{M_2'}{S_2'}}{M_1'} dA = \frac{1 + \frac{0.0005}{0.3}}{0.5} 10 = 20.03$$

$$= \text{approximately } 20\% \text{ of } Y_{\text{small area}}.$$

The relative effects of income increases in the small area as compared to the large area are a function of the import propensities of the areas and the propensity to save of the large area. Several qualitative conclusions may be derived, but for our purposes the important point is that a small area export expansion is consistent with a growth process in either the large area or the small area. The export increase produces repercussions, but the earlier multiplier comparison shows that these were so minor for a small area facing a large area that the repercussion effect can be ignored.

E. Previous Export Base Approximation Methods

This section documents a selection of past attempts to make export base approximations. An approximation in this context refers to any derivation of basic versus non-basic activity that was not based in substantial part on primary data gathered in the area for which the estimate was made.

Three general types of approximations can be identified as: (1) manipulation of ratios or differences resulting from comparisons of the economic activity pattern of the area with the economic activity pattern of the region or nation with which the area trades, (2) arbitrary assignment of an "appropriate" percentage to each sector of activity such that this percentage represents the proportion of the sector's activity which is considered basic, (3) arbitrary assignment of the total activity of a sector entirely to either the basic or non-basic category. The three types of approximations will be discussed in more detail in the order that they are listed above.

The first method involves the comparison of area with regional or national economic activity patterns. Andrews (7, p. 166) has named this technique the macrocosmic method and described it as follows:

> "Base identification by the macrocosmic method is...used principally in large urban areas where more detailed techniques would be costly and time-consuming. What this approach does, in essence, is to make a comparison of the employment pattern of the area under study with that of the nation at large. As one research team expressed the idea:
>
> > '...manufacturing currently employs 40 percent of all gainfully employed persons in the Chicago area, whereas the national percentage is 27.... It may be inferred, therfore, that the goods produced by these 13 percent extra workers are probably destined for export markets.'
>
> It is not assumed, of course, that each urban area conforms strictly to the national pattern of production and consumption. But it is felt that relationships such as the one described

will indicate the rough magnitude of local employment as compared to a national norm."

The assumptions of the macrocosmic model may be stated somewhat differently in a form that leads directly to a mathematical description. A ratio of national activity in a certain sector to total national activity is calculated. In the notation previously used this ratio for the jth sector is represented by $\frac{V_{mjtt} + V_{ojtt}}{V_{mttt} + V_{ottt}}$.

It is then assumed that the above ratio represents the proportion of an area's total activity that is engaged in supplying the area's domestic demand for the product of sector j. In symbols, $\frac{V_{mjtt} + V_{ojtt}}{V_{mttt} + V_{ottt}} \cdot V_{dttt} = V_{ajtt}$.

After V_{ajtt}, the non-basic activity of sector j, is so determined, the export activity of sector j is the difference between total activity of sector j and non-basic activity of sector j provided this difference in non-negative.

A negative difference can result whenever an area sector does not have a total level of activity as large as the computed level of domestic activity for that sector. The usual assumption in this case is that domestic activity accounts for whatever total activity there is. Consequently, export activity for the area sector is zero whenever strict adherance to the formula would produce a negative value.

Mantilla and Thompson (28) have shown how the variables used above can be combined in various ways to form indexes as well as absolute measures. The computation carried out above is equivalent to their absolute measure of surplus workers. In addition, they studied the uses of location quotients, indexes of local specialization, indexes of surplus workers and combinations of these, each of which involves a different formulation of the same variables.

Homer Hoyt (52, pp. 109-110) was one of the first to describe the macrocosmic method in some detail although he apparently did not use it on all sectors. He has reported his involvement in more than 12 empirical urban area studies which included economic base determinations (21).

Ralph Pfouts (32) followed Hoyt's lead in calculating basic employment for a study in which he attempted to test the economic base theory.

The second approximation method involves the arbitrary assignment of a given percentage of a sector's total activity to basic activity. The determination of the percentage values considered appropriate respectively for each of the sectors is presumably based in each case on the use of as much information as the investigator possesses. If only one area is being described, the quality and quantity of such information may be relatively high with skilled interpretations of personal observations adding to the accuracy of the estimate. Examples in this context are economic base studies of the "Tenco" and

"Niad" areas of Iowa by Ronald Powers (33) and Eber Eldridge (15).

On the other hand, if a study involves a number of areas, and a common set of percentages is applied to each area, some questionable assumptions must be involved. In particular, it must be assumed either that, for the areas involved, a given sector's export orientation is in no way affected by its area identification or that area effects are identical.

A recent example of the use of the common export percentage set is Lee Martin's study (29) of "autonomous-dependent" ratio changes over time for the nation where "autonomous" and "dependent" were defined with regard to areas of the size of the Census Bureau's state economic areas. He assumed that the following export percentage set would apply on the average to sectors of state economic areas: Agriculture - 90 percent, Mining - 90 percent, Manufacturing - 80 percent, Construction - 20 percent, Trade - 10 percent, Finance - 60 percent, Transportation - 40 percent, Communications - 50 percent, Utilities - 40 percent, Services - 30 percent, and Government - 40 percent. Martin also assumed that this set of percentages would remain the same over time for the sectors involved.

The third approximation method involves the assignment of sectors entirely to either the basic or non-basic category.

This method might be called the polar system of export-residentiary classification. It can be considered a special case of the second method. It is special in the sense that the only permitted values for the export percentage of a sector are one hundred and zero. It has generally been used where only rough estimates were wanted and where it was assumed that sectors were either heavily export-oriented or heavily domestic-oriented. In this case the errors involved would largely cancel out when aggregate export and domestic totals were summed.

Karl A. Fox (18, p. 349) has used the polar system for estimating area export versus residentiary employment totals. In the context of a discussion on functional economic areas (FEA's) he states:

> "Having defined such a relatively self-contained area and the cluster of "residentiary" activities with respect to which the FEA is approximately "closed", we may make an approximate separation of the economic activities carried on in the FEA between residentiary and export oriented. In relation to an area or small region of this size (about 5,000 square miles under Iowa conditions), agriculture, forestry and fisheries, mining, transportation and manufacturing are preponderantly export oriented while all the rest are primarily residentiary in nature."

In another publication, Fox (17) presented a more detailed breakdown of his classification of industry groups into either export-oriented or residentiary-oriented categories. The former included Agriculture, Forestry and Fisheries, Mining, Manufacturing, all Transportation and a proportionate share of Industry Not Reported. The residentiary-oriented category included Construction, Communications, Utilities and Sanitary Services, Wholesale and Retail Trade, Finance, Insurance and Real Estate, Business and Repair Services, Personal Services, Entertainment and Recreation Services, Professional and Related Services, Public Administration and a proportionate share of Industry Not Reported.

In all the studies cited in this section and in many others not cited directly, investigators have derived export-residentiary ratios of one or more types. Also in every cited case, and in others, some ratios have been approximated in order to generate data which would produce other ratios.

The three sector model previously described can be used to illustrate ratios which have been derived. Following are such ratios in both general notation and in numerical form for a hypothetical three sector model:

$$V_{e1tt}/V_{d1tt} = 9{,}100/10{,}000 = 0.91 \tag{21}$$

= portion of Sector 1 employment which is export.

$$V_{e2tt}/V_{d2tt} = 8{,}900/10{,}000 = 0.89 \tag{22}$$

= portion of Sector 2 employment which is export.

$$V_{e3tt}/V_{d3tt} = 5{,}900/30{,}000 = 0.197 \tag{23}$$

= portion of Sector 3 employment which is export.

$$\frac{V_{e1tt} + V_{e2tt} + V_{e3tt}}{V_{d1tt} + V_{d2tt} + V_{d3tt}} = \frac{23{,}900}{50{,}000} = 0.478 \tag{24}$$

= portion of total employment which is export.

The reciprocal of (24) = 2.092 (24-a)

= the area export multiplier.

$$\frac{V_{a1tt} + V_{a2tt} + V_{a3tt}}{V_{e1tt} + V_{e2tt} + V_{e3tt}} = \frac{V_{attt}}{V_{ettt}} = \frac{25,700}{24,300} = 1.092 \qquad (25)$$

= the residentiary-export ratio

= the export multiplier minus one.

The multiplier, strictly speaking, is a marginal concept, but the average relationship of Ratio 24-a is often used as an approximation of the multiplier.

Ratios 21, 22, 23 and 24 can each be multiplied by an activity total of an area and the product will be an estimate of export activity related to that total. The reciprocal of Ratio 24, the area export multiplier, can be multiplied by an export quantity (usually a projected quantity) to produce an estimate of a total quantity related to that export quantity. Ratio 25 uses the same data as Ratio 24 in a different form to produce a multiplier suitable for estimating total residentiary activity associated with total export activity.

It can be noted by simple inspection that all the ratios described above involve export activity in either the numerator or denominator. Residentiary activity enters the picture explicitly only in Ratio 25 and even there it could be considered a residual after total activity and basic activity are known.

The point to be emphasized is that the stress that has been placed upon basic activity as being "primary" in some sense has apparently caused investigators to look for ways to approximate basic activity levels directly. Non-basic activity has been left to arrive at whatever residual levels it must have in order to meet the definitional requirement that basic plus non-basic activities equal total activity. It is exactly this method of approach that is questioned in some detail at a later point in this study.

When certain ratios are approximated in order to generate data for economic base studies, the approximation probably always involves a "borrowing" of information in some sense. The internal relationships of either the nation or some other area or areas are assumed to apply, perhaps with adjustments, to the area being studied. One or more ratios are borrowed and applied to known activity totals of the area being studied in order to generate sub-totals which may be reaggregated in various combinations in order to "create" values for variables which the investigators wish to study.

Approximation methods of reasonable reliability in generating basic and non-basic activity sub-totals will likely remain in demand for several reasons, namely; (1) values for total activity levels are generally available at low cost from census publications and other surveys of various types, (2) a moderate number of empirically oriented economic base studies have been completed in most areas of the nation from which appropriate ratios could be borrowed, (3) the cost of conducting an empirical economic base survey in any area and particularly in areas of heavy urban employment is quite high.

III. METHOD OF PROCEDURE

A. Criticism of Previous Approximation Methods

The process of searching for low-cost ways to increase the precision of economic base approximations may properly begin with a critical look at the methods that have been used to date. The point of departure for this study is a questioning look at the rationale for transferring base ratios from area to area or from the nation to the area. It is necessary particularly to look at some sources of variation in base relationships among areas and to see how these may affect the reliability of approximations.

There is probably general agreement among regional economists that the over-all basic-nonbasic relationship of an area changes over time and that it varies with the size of the area being considered. Per capita income and income distribution differences are also advanced as reasons for variation of the over-all ratio. If we compare areas of different size or at different points in time or with differing income characteristics we might suspect that the over-all basic-nonbasic ratios would be found to be different.

The question now arises: What conditions, if any, will cause the basic-total ratios of the sectors to vary among areas? In changing our focus of attention from the area as a whole to sectors of an area, we introduce a new possibility of variation among areas. This is the variation where corresponding sectors of areas make up differing proportions of the area totals. For example, agriculture may provide 30 percent of total employment in one area and only 10 percent of total employment in another area. At least one other sector must then also be different in its percentages of the totals of the two areas, and probably all sectors will be more or less different. If two areas differed only in the proportions represented by comparable sectors (assuming area size, point in time, income per capita, and income distribution to be identical) is it reasonable to assume that the comparable sectors should each be export oriented to the same degree?

When the question is asked this way it seems difficult to find a logically tight argument to use in defending either a yes or a no answer. However, the question can be expanded by noting that when the basic-total ratio is specified for a sector the nonbasic-total ratio is simultaneously fixed. If we say that the sector of Agriculture is 90 percent basic, we are also saying that it is 10 percent nonbasic.

To illustrate the point more clearly by example let the hypothetical three-sector area previously described be further identified by sectors. Sector 1 may be called Agriculture sector 2 is Manufacturing and sector 3 is Services.

In the numerical example the service sector was shown as being 19.7 percent export oriented. Services represented 60 percent of total employment. The residentiary-service-worker to total-worker ratio is 23,900/50,000 = 0.478. Suppose another area is found, again with 50,000 workers, where Services employment is 40,000 workers or 80 percent of the total. If we say that 19.7 percent of this is export then 80.3 percent must be residentiary. If this is true, 32,120 service workers must be residentiary and the ratio of residentiary service workers to total workers is 32,120/50,000 = 0.642.

Why should one area demand or use, relatively, so much more residentiary Services employment than the other? Is this realistic or has a serious error been made by assuming that the export-total ratio of a sector is relatively stable from area to area and that the sector's residentiary employment can be derived as a residual?

B. The Hypothesis and Model

1. The hypothesis and the general model

The author would hypothesize that relative stability from area to area is much more likely to be found in a quite different type of ratio, namely; the sector residentiary to total area employment ratio. This ratio expresses the demand which the total employment (and the population associated with it) generates for locally produced goods and services. When it is said that such ratios are stable, then it is implied that areas of similar size and similar income parameters will need about the same number of retail clerks, auto mechanics, filling station attendants, barbers and beauty operators, utility workers, newspaper staff, insurance agents and clerks, teachers, local government workers and other residentiary workers. Intuitively, it seems that this hypothesis is much more reasonable than one which states that the sector residentiary to total worker ratios are highly dissimilar among areas. No investigator has made the latter hypothesis directly, but it has been implied indirectly whenever stability of sector export to sector total ratios was assumed and dissimilar areas were included in the investigation.

Only with empirical data can the hypothesis of relative stability of the sector residentiary to total employment ratio (hereafter designated as the SR/TE ratio) be supported or rejected. However, it is possible to illustrate the differential results obtained by the use of these ratios. The SR/TE ratio for services from the numerical example is:

$$\frac{V_{a13t} + V_{a23t} + V_{a33t}}{V_{d1tt} + V_{d2tt} + V_{d3tt}} = \frac{V_{at3t}}{V_{dttt}} = 0.482$$

If this ratio is applied against another area of 50,000 total employment it will produce an estimate of residentiary Services employment of 23,900. If this area has 40,000 total Services workers, the export estimate would be the residual of 40,000 - 23,900 = 16,100 export Services workers.

An estimate produced by this method would indicate that the Services sector in the second area includes a much larger export element than does the Services sector in the base area (Services export = 5,900) from which the borrowed ratio was derived.

If the second area were Polk County, Iowa, with its large insurance company home office employment (classified as Services in our three-sector economy) or Ames, Iowa and surroundings with its university and government employment, the SR/TE ratio method would correctly identify Services as a major export sector. The method should also reduce Services to a minor export role in relatively rural areas where we expect to find Agriculture as the only major export sector.

The three-sector technology matrix previously illustrated is actually an expansion of the SR/TE ratios. The matrix specifies the intra-area relationships of every sector to every other sector. If it is said that these ratios are stable, the assumption is that the per unit demand of a sector upon another sector is stable among areas.

The matrix provides more flexibility than the SR/TE ratios. With n sectors there will be n SR/TE ratios. The technology matrix provides n^2 ratios and allows for differential demands among sectors within areas. These differential demands might result either from differential consumption patterns among families of workers of different sectors or from differential local factor supply patterns to production activities among different sectors. If there were no differentials of the kinds just mentioned then the elements of each row of the technology matrix would be identical and would be equal to the SR/TE ratio of the respective sector. If the elements of a given row are not identical, the SR/TE ratio is a weighted average of these elements.

The hypothesis of relative stability among areas for the SR/TE ratios is not essentially changed by introducing the technology matrix. It is, however, extended by the implication that a more refined degree of stability is obtained than by using the SR/TE ratios.

The hypothesis also includes the qualification that the matrix stability exists under conditions of similar size, similar points in time and similar income parameters in the areas being compared. If we wish to deal with areas for which size, time or income characteristics vary, then it is necessary to know the way in which elements of the matrix vary with variation of size, time and income.

Assume for the moment that we have this knowledge and that we have a technology matrix which was empirically derived from some area. Call this matrix [A]. Now for any other area which we wish to describe we have for 1960 the breakdown of total employment by sectors. Call the column or vector of total employment (X). We wish to approximate the export employment of each sector. The relationship which corresponds to equations 18, 19 and 20 is in matrix notation:

$$[A] \quad (X) + (Y) = (X)$$

where (Y) is the unknown vector or column of export employment.

By rearranging we may solve for (Y) as follows:

$$(Y) = (X) - (AX) = [I - A]\ (X)$$

The elements of (Y), the export magnitudes of all sectors, will be uniquely determined. The economic base of an area, in an export-residentiary sense, has been approximated without recourse to a single item of primary empirical data. The correctness of the approximation rests on the validity of the assumption that the matrix [A] can be transferred from area to area.

2. Formal specification of the model

The formal model for the study can be presented in the four-place subscript notation previously used. The most general framework will be presented by providing for n sectors in the following specification.

A firms-to-firms technology matrix is described by the following matrix:

$$\begin{bmatrix} V_{a11f}/V_{d1tt} & V_{a12f}/V_{d2tt} & \cdots & V_{a1nf}/V_{dntt} \\ V_{a21f}/V_{d1tt} & V_{a22f}/V_{d2tt} & \cdots & V_{a2nf}/V_{dntt} \\ \vdots & \vdots & & \vdots \\ V_{an1f}/V_{d1tt} & V_{an2f}/V_{d2tt} & \cdots & V_{annf}/V_{dntt} \end{bmatrix}$$

Let the above matrix be designated as $[A_f]$.

A firms-to-households technology matrix is described by the following matrix:

$$\begin{bmatrix} V_{a11h}/V_{d1tt} & V_{a12h}/V_{d2tt} & \cdots & V_{a1nh}/V_{dntt} \\ V_{a21h}/V_{d1tt} & V_{a22h}/V_{d2tt} & \cdots & V_{a2nh}/V_{dntt} \\ \vdots & \vdots & & \vdots \\ V_{an1h}/V_{d1tt} & V_{an2h}/V_{d2tt} & \cdots & V_{annh}/V_{dntt} \end{bmatrix}$$

Let the above matrix be designated as $[A_h]$.

Using matrix addition we may specifiy that:

$$[A_h] + [A_f] = [A_t]$$

$[A_t]$in expanded notation is the following:

$$\begin{bmatrix} V_{a11t}/V_{d1tt} & V_{a12t}/V_{d2tt} & \cdots & V_{a1nt}/V_{dntt} \\ V_{a21t}/V_{d1tt} & V_{a22t}/V_{d2tt} & \cdots & V_{a2nt}/V_{dntt} \\ \vdots & \vdots & & \vdots \\ V_{an1t}/V_{d1tt} & V_{an2t}/V_{d2tt} & \cdots & V_{annt}/V_{dntt} \end{bmatrix}$$

All elements of $[A_f]$ and $[A_h]$ are required to be non-negative since negative coefficients would have no economic meaning. Both $[A_f]$ and $[A_h]$ may or may not include zero elements. A zero element means that the sector identified by the row number supplies nothing to the sector identified by the column number. This may occur in scattered locations in the firms-to-firms technology matrix, especially if sectors are relatively disaggregated.

If all households were identified as a sector, say the mth sector, the mth column of the firms-to-firms technology matrix would consist entirely of zero elements. At the same time the firms-to-households matrix would have zero elements in all columns except the mth column.

If households are attached to sectors with which they are associated through sales of their labor, it is possible that all elements in both the firms to firms and firms to households technology matrices will be positive.

The process of transferring a technology matrix from area to area must include a provision for adjusting the matrix for area differences in size, income parameters and perhaps other characteristics. The general method for such adjustments will involve the use of diagonal matrices designed to be multiplied against the technology matrix. Post-multiplication by a diagonal matrix will allow differential changes of columns of the technology matrix but each element in a column will change by the same proportion. Pre-multiplication by a diagonal matrix can change rows differentially but each element in a row is changed by the same proportion.

3. Hypothesis testing possibilities

Attempts to test the hypothesis of relative stability of the technology matrix among areas are not likely to give sharp and unambiguous results. Too many variables are involved. The number of variables must be reduced drastically by aggregation. The type and degree of aggregation are dictated by a combination of *a priori* reasoning and availability of data. Primary data is limited because of extremely high cost of its acquisition particularly in urban areas. The high cost is primarily the result of the lack, to date, of suitable sampling procedures which could substitute for a complete survey of all firms in an economic base survey.

If variations are permitted for differences in size, income parameters and points in time, it is possible that the hypothesis could appear to be refuted because the incorrect adjustments are being used for one or more of these differences. Again it is a case of too many variables being involved for the amount of data available.

Under these conditions the testing must proceed under a sort of iterative procedure. Some extreme permissible limits on values for elements of the export vector will be developed by introspection. A persistent tendency of the model to produce values outside these limits will be strong grounds for refutation of the hypothesis. If the hypothesis is not refuted by this test, comparisons of its results with those of other studies and with other secondary data analysis methods applied to the same areas will be made. Other models have given "intuitively correct" results for many urban areas and "intuitively incorrect results for others. If the model under consideration can produce a noticeably greater proportion of "correct" results there will exist strong intuitive grounds for support of the hypothesis.

C. Investigation Procedure

1. Data sources

In 1964 an economic base survey was conducted in the seven county Midcrest area of Southern Iowa in a joint effort by central staff and field staff members of the Iowa State University Cooperative Extension Service. The original purpose of the survey was the gathering of data for the preparation of an economic base study of the area, which study (16) was subsequently published. A questionnaire to be used with business firms was designed in such a way as to uncover both export sales and sales within the area which would be found to be "indirect export" sales.

During the survey planning period it was observed that a framework which could describe export and indirect export activity would by necessity evolve into something equivalent to a matrix formulation. From this recognition came the thought that if the matrix were carefully developed and related to secondary data totals it might be transferable to other areas. Accordingly, this potential use was kept in mind during the data gathering and analysis stages of the survey.

A facsimile of the Southern Iowa questionnaire is contained in Figure 1. Firm managers were asked to list the number of employees in 1960 and in 1963. They identified the

MANUFACTURING AND BUSINESS QUESTIONNAIRE - So. Iowa

1. Name of firm?______________________________

2. Location of firm?______________________________
(town) (county)

3. What are the major products or services of your firm?_____

____

4. How many people (full-time equivalents) were employed in your firm during 1960 and 1963? What percent of these were women?

	Number Employed	Percent Women
1960	________	________
1963	________	________

5. Of your total gross sales, what percent was sold to:

	1960	1963
Persons or firms outside the area?	____	____
Wholesale and retail firms in the area?	____	____
Manufacturing firms in the area?	____	____
Construction and mining firms in the area?	____	____
All other firms in the area?	____	____
Farmers for farm use in the area? (not for home use)	____	____

Figure 1. Facsimile of questionnaire used in survey of transactions activity of Midcrest firms

products or services of their firms in sufficient detail so that each could be classified to at least a three-digit level according to the standard industrial classification code of the U.S. Bureau of the Budget (39). The managers were asked to list, for the two years, the percentage breakdown of their sales by recipients according to export or sectors-within-the-area categories. The residual of total sales minus sales reported was treated as sales to consumers in the area.

Sales transactions were thus identified from the seller's viewpoint. No questions were asked concerning purchases either as to amount or source. Thus imports were not measured at all, and intra-area transactions were not cross checked in any way.

In the follow-up analysis of the data it was assumed that employees' time is divided in the same proportions, within the firm, as sales are divided. Thus, the total of economic activity for the firm is in terms of employment, and the breakdown of employment into meaningful categories is in accordance with the sales breakdown. This round-about procedure avoided the delicate question concerning total sales of firms in absolute terms.

It was recognized at the beginning that resources available for conducting the survey were insufficient to unearth all the economic activity of the seven-county area. Therefore, secondary data from census sources would be required in order to provide totals of sector activity levels. The 1960 Census of Population (45, pp. 262-269) could provide a set of such totals in employment by industry terms by counties. Data which related employment and industry to firms was also needed. At the county level this is reported by the County Business Patterns series of the Census Bureau (40, pp. 9-85). The 1962 issue of this series is midway in time between the 1960 Population Census and the 1964 date of the survey.

The number of sectors into which total activity could be divided was ultimately controlled by the degree of disaggregation available in the secondary data sources. The County Business Patterns breakdown was the least disaggregated and so the number of sectors identified for analysis was the maximum number that could be extracted from the County Business Patterns data plus the sector of Agriculture.

The area of Iowa involved in the survey consists of seven counties: Adair, Adams, Clarke, Decatur, Ringgold, Taylor and Union. The total number of firms surveyed in this area was 405. Adair County did not participate actively in the survey. The total number of firms listed for the seven counties in the County Business Patterns data was 1,344 in 1962. It appears, therefore, that somewhat less than one-third of the firms were interviewed. Actually, a somewhat selective procedure was used in selecting sectors and sub-sectors to be interviewed intensively and those to be ignored. Banks and other financial institutions, for example, were not interviewed because of the difficulty in defining sales of a bank. Similarly, beauty parlors and barber shops were ignored on the assumption that practically all of their activity consists of sales to consumers, and there was no need to survey these firms to discover that fact.

In general, it may be said that the primary goal of the survey was to reach firms of sub-sectors which by a priori estimation were thought to be substantially engaged in at least two of the three categories of export activity, indirect support of export and/or consumption activity. "Sub-sector" in this context refers to groups of firms at the two, three, or four-digit level of disaggregation.

The empirical content of the study was thus concentrated on the gathering of substantial sales and employment data to use in dividing economic activity of sub-sectors which could not "reasonably" be allocated by macrocosmic, export percentage approximation or polar methods. Other sub-sectors were allocated by the latter methods where it appeared justifiable, or in other cases, notably with Agriculture, where no empirical alternative appeared to be feasible. A more detailed account of the area activity analysis procedure is given at a later point.

The end result of the analysis is a transactions matrix which is the sum of a firms-to-households matrix and a firms-to-firms matrix as outlined in the formal model. The transactions matrix is in employment terms and consists of eight sectors making it an 8 x 8 square matrix. This transactions matrix, when post multiplied by the appropriate diagonal matrix, as previously illustrated, yields the technology matrix for the area. It is this technology matrix of the Midcrest area that becomes, in a sense, a part of the data to be used in testing the hypothesis. This matrix, together with the vector of total employments in eight sectors for the area undergoing export approximation provide all of the data to be used in approximating the export vector for the other area.

The resulting export vector can be tested for realism by the methods previously outlined. If such tests for many areas fail to uncover an unrealistic export vector, there will then be reason to presume that the technology matrix is a good approximation of the true technology matrices that would be found if empirical surveys were conducted in all areas.

2. Permissible export limits

The usual static open-model input-output problem involves the determination of a required vector of total sectoral outputs that is associated with a given vector of final demands (exports in our model). In matrix notation the following solution is sought: $(X) = [I-A]^{-1} (Y)$.

For economic realism it is desirable that for any given set of positive final demands a set of positive total outputs exists that is capable of satisfying the final demand set. For realism in our problem it is required that each element of the computed export vector have a value not less than zero nor greater than the total output of its sector. Negative exports are meaningless in economic terms, and a sector export magnitude exceeding total sector output is impossible.

The export vector is derived from the following matrix formulation: $(Y) = (X) - [A](X)$.

Using lower case letters to denote elements of the vectors and matrix, the solution for the ith sector is,

$$y_i = x_i - a_{i1}x_1 - a_{i2}x_2 - \cdot \cdot \cdot \cdot - a_{im}x_m.$$

It can be seen by inspection that y_i will not exceed x_i so long as all the a_{ij}'s, $j = 1, 2, \cdot \cdot \cdot, m$, are zero or positive, a condition which exists in the Midcrest matrix.

However, simple inspection can produce no rule to guarantee that y_i will always be non-negative. On the contrary, any x_j where j does not equal i can, in principle, be large enough so that, provided a_{ij} is positive, $a_{ij}x_j$ is larger than x_i and will produce a negative y_i. Alternately, a combination of moderately large x's associated with moderately large a's could produce the same unwanted result.

The effect of negative export elements in an approximation of an export vector is to cast serious doubt on the validity of the hypothesis that the technology matrix is relatively stable among similar areas. The rationale for this conclusion is based on the knowledge that there must be a true technology matrix for the area that would not produce negative exports. This is so because actual exports, zero or positive, are subtracted from total activity before the technology matrix is derived. If the borrowed matrix produces some negative exports when applied against known sector totals, it cannot be a good approximation of the true matrix for that area. The stability of the technology matrix hypothesis in this case would fail to pass the test through the failure of the matrix to produce export values within permissible limits.

3. Arrangement of population census data

The organization and manipulation of data on total employment in the Midcrest area is presented in a series of tables. Table 1 is the key table in the sense that it lists, by industry of employment, each of the levels of aggregation of data that are used in following tables. The word "industry" is here introduced as a synonym for "sector" and is used frequently in the latter part of this study to conform with the practice of the Bureau of the Census. For each identification of industry of employment a cross reference line number is assigned. Each such line number remains attached to the same industry of employment identification in following tables, and thus the line number serves as a reference for comparison and continuity among tables.

Table 1 also presents the source of data for numerical values which are assigned to industry of employment categories in following tables. The bulk of the data is from the 1960 Census of Population (45). Where the designation, "Population Census, adjusted", is used, the interpretation should be that the numbers reported in the census publication have been

Table 1. Organization of data on total employment in Midcrest in 1960, by industry of employment, source of basic data, and manipulations of data

Line no.	Industry of employment	Source of basic data and data manipulations
1	Agriculture and Related	Sum of lines 2 and 3.
2	Agriculture	Population Census, adjusted.
3	Forestry and Fisheries	Population Census, adjusted.
4	Construction and Related	Sum of lines 5 and 6.
5	Mining	Population Census, adjusted.
6	Construction	Population Census, adjusted.
7	Manufacturing and Related	Sum of lines 8, 17, 18, 21, and 22.
8	Durable Goods	Sum of lines 9 through 16.
9	Furniture and Lumber and Wood Products	Population Census, adjusted.
10	Primary Metal Industries	Population Census, adjusted.
11	Fabricated Metal Industries	Population Census, adjusted.
12	Machinery, except Electrical	Population Census, adjusted.
13	Electrical Machinery, Equipment and Supplies	Population Census, adjusted.

Table 1. (continued)

Line no.	Industry of employment	Source of basic data and data manipulations
14	Motor Vehicles and Motor Vehicle Equipment	Population Census, adjusted.
15	Transportation Equipment, except Motor Vehicle	Population Census, adjusted.
16	Other Durable Goods	Population Census, adjusted.
17	Food and Kindred Products	Population Census, adjusted.
18	Textile and Apparel Products	Sum of lines 19 and 20.
19	Textile Mill Products	Population Census, adjusted.
20	Apparel and Other Fabricated Textile Products	Population Census, adjusted.
21	Printing, Publishing and Allied Products	Population Census, adjusted.
22	Miscellaneous Non-Durables	Sum of lines 23 and 24.
23	Chemical and Allied Products	Population Census, adjusted.
24	Other Non-Durable Goods	Population Census, adjusted.
25	Trade, Wholesale-Retail	Sum of lines 26, 27, 28, 30, 31, 32, and 33.
26	Wholesale Trade	Population Census, adjusted.

Table 1. (continued)

Line no.	Industry of employment	Source of basic data and data manipulations
27	Food and Dairy Products Stores	Population Census, adjusted.
28	Eating and Drinking Places	Population Census, adjusted.
29	Other Retail Trade	Population Census, unadjusted, divided into industries of lines 30, 31, 32, and 33.
30	Building Materials and Farm Equipment	CBP allocator times line 29, adjusted.
31	Automotive Dealers and Service Stations	CBP allocator times line 29, adjusted.
32	Miscellaneous Retail Stores	CBP allocator times line 29, adjusted.
33	General Merchandise and Other Retailers	CBP allocator times line 29, adjusted.
34	Transport and Related	Sum of lines 35 through 39.
35	Railroad and Railway Express Service	Population Census, adjusted.
36	Trucking Service and Warehousing	Population Census, adjusted.
37	Other Transportation	Population Census, adjusted.
38	Communications	Population Census, adjusted.
39	Utilities and Sanitary Service	Population Census, adjusted.
40	Finance and Related	Same as line 41.

Table 1. (continued)

Line no.	Industry of employment	Source of basic data and data manipulations
41	Finance, Insurance and Real Estate	Population Census, adjusted.
42	Services and Related	Sum of lines 43 through 53.
43	Business Services	Population Census, adjusted.
44	Repair Services	Population Census, adjusted.
45	Private Households	Population Census, adjusted.
46	Other Personal Services	Population Census, adjusted.
47	Entertainment and Recreation Services	Population Census, adjusted.
48	Hospitals	Population Census, adjusted.
49	Education Services: Government	Population Census, adjusted.
50	Education Services: Private	Population Census, adjusted.
51	Welfare, Religious and Non-Profit	Population Census, adjusted.
52	Other Professional and Related Services	Population Census, adjusted.
53	Public Administration	Population Census, adjusted.
54	Industry Not Reported	Population Census, total vanishes at first adjustment.

Table 1. (continued)

Line no.	Industry of employment	Source of basic data and data manipulations
55	Commuters Net Outflow	Estimate from special survey is entered at second adjustment.

subjected to two adjustments. The first adjustment is an allocation of the Industry Not Reported number to the reported industries in proportion to the fraction which the employment of each reported industry was of the sum of the employment of all reported industries.

The second adjustment involved the introduction of a Commuters Net Outflow industry into which are placed the number of out-commuters into the area. If Commuters Net Outflow is a positive quantity, an equal number of employees must be deducted from other named industries in order to avoid double-counting of employees residing in the area. If Commuters Net Outflow is a negative quantity, an equal number (positive) must be added to other named industries in order to avoid under-counting the number of jobs in the area.

The degree of disaggregation found in the Population Census is used without further breakdown except for the industry, Other Retail Trade. Because a substantial volume of survey data was available by sub-categories of Other Retail Trade, it was thought desirable to divide the census reported data into the sub-categories. Data from the County Business Patterns publication for 1962 (40, pp. 17-85) for the counties involved was used to generate allocators. Employment reported by the Population Census as Other Retail Trade was divided into the industries of Lines 30, 31, 32, and 33 respectively according to the proportion which employment of each of the latter industries was to the sum of employment of the latter industries in the 1962 County Business Patterns data. The "CBP allocator" is the appropriate proportion in each case.

It may be noted also that Table 1 presents a three-step level of indentation for the listed industries of employment. The unindented industries are the ones that appear at a later point as the aggregated industries in an eight-sector matrix of coefficients which is a central part of this study. It can be seen that these sectors are the ones listed in Lines 1, 4, 7, 25, 34, 40, 42, and 55. It may be noted that none of these sectors received data reported directly from the census or any other source, but are rather the sum of industries reported on other lines. The once indented industries, illustrated by Agriculture, Forestry and Fisheries, Mining and others similarly indented are in most cases industries with data reported directly from the population census. Exceptions to this later statement exist, however, since Line 8, Durable Goods, is a sum of a number of named industries of the Population Census. Similarly Lines 18 and 22 are formed by combining some named industries of the Population Census. In these cases the reported industries which have been so combined were assigned to the twice indented level. This greatest level of indentation includes a mixture of data sources. In addition, to the reported industries of the Population Census, it includes a number of sectors identified by County Business Patterns data and the Industry Not Reported sector which, during the data adjustment process, is allocated to all of the other sectors.

Table 2 ties together the set of line numbers with the set of named industries and the set of standard industrial classification code numbers. The code numbers presented are those that are listed in the 1960 Census of Population (45, p. xxii) as being appropriate for the industries which are reported by name in the census breakdown of industry of employment for counties. Table 2 presents industries of employment in the most disaggregated form in which data from either secondary sources or the area survey was analyzed. It may be noted that named industries which are aggregations of two or more of the Table 2 industries are not presented in Table 2. For example, if at some point the reader wishes to know which industries as identified by standard industrial classification codes are included in the term Agriculture and Related, it is necessary to first determine from Table 1 that Agriculture and Related is a sum of Lines 2 and 3 and Lines 2 and 3 are shown in Table 2 as being equivalent to the code numbers 01, 07 except 0713, 08 and 09. For the precise word designations attached to each standard industrial classification code number, the reader is referred to the 1957 Standard Industrial Classification Code Manual (39). The code numbers corresponding to Lines 30, 31, 32 and 33 were determined from information presented in the 1962 County Business Patterns publication (40). The codes listed for the latter four line numbers are the ones which, in total, exhaust the code numbers listed in the Population Census for Other Retail Trade. Table 1 shows that Other Retail

Table 2. Industries identified by appropriate standard industrial classification, code designation, and appropriate line number from table 1

Line no.	Industry of employment	Standard industrial classification code designation
2	Agriculture	01, 07 except 0713
3	Forestry and Fisheries	08, 09
5	Mining	10 through 14
6	Construction	15 through 17
9	Furniture and Lumber and Wood Products	24, 25
10	Primary Metal Industries	33
11	Fabricated Metal Industries	34
12	Machinery, except Electrical	35
13	Electrical Machinery, Equipment and Supplies	36
14	Motor Vehicles and Motor Vehicle Equipment	371
15	Transportation Equipment, except Motor Vehicle	37 except 371
16	Other Durable Goods	194, 32, 38, 39
17	Food and Kindred Products	0713, 20
19	Textile Mill Products	22

Table 2. (continued)

Line no.	Industry of employment	Standard industrial classification code designation
20	Apparel and Other Fabricated Textile Products	23
21	Printing, Publishing and Allied Products	27
23	Chemical and Allied Products	28
24	Other Non-Durable Goods	21, 26, 29 through 31
26	Wholesale Trade	50
27	Food and Dairy Products Stores	54
28	Eating and Drinking Places	58
30	Building Materials and Farm Equipment	52
31	Automotive Dealers and Service Stations	55
32	Miscellaneous Retail Stores	59
33	General Merchandise and Other Retailers	53, 56, 57
35	Railroad and Railway Express Service	40
36	Trucking Service and Warehousing	42
37	Other Transportation	41, 44 through 47
38	Communications	48

Table 2. (continued)

Line no.	Industry of employment	Standard industrial classification code designation
39	Utilities and Sanitary Service	49
41	Finance, Insurance and Real Estate	60 through 67
43	Business Services	73
44	Repair Services	75, 76
45	Private Households	88
46	Other Personal Services	70, 72
47	Entertainment and Recreation Services	78, 79
48	Hospitals	806
49	Education Services: Government	82
50	Education Services: Private	84
51	Welfare, Religious and Non-Profit	86
52	Other Professional and Related Services	80 except 806, 81, 89
53	Public Administration	91, 94
54	Industry Not Reported	99

Trade, identified as Line 29, is the aggregate which is divided into Lines 30, 31, 32 and 33. Thus consistency has been maintained between the Population Census and the County Business Patterns report with respect to the identification of indus-tries of employment.

4. Presentation of empirical data

Table 3 presents the first overview of numerical data for the Midcrest area. The table presents, by industry of employment, the format which permits the relating of data on the number of firms surveyed, the employment of the surveyed firms, and the 1960 Population Census reported employment, in adjusted form, so that some appreciation might be gained of the degree to which empirical data was used in the derivation of the eight-sector inter-industry transactions matrix. The only industries listed are those for which some empirical data, no matter how insignificant, was obtained. The table is also useful in that it highlights a number of difficulties which seem to appear in the process of data gathering and analysis, and which dictated some of the aggregation procedures that were used. An inspection of Lines 11 and 12 will illustrate one interesting situation. For Line 11, three firms were surveyed and together reported a total of 74 employees in 1960. However, the 1960 Population Census listed only 11 employees which could qualify under the named industry, Fabricated Metal Industries. A number of occurrences could cause such a discrepancy. It is possible that one or more of these firms either started operations

Table 3. Number of firms surveyed, employment of surveyed firms, and 1960 population census reported employment (adjusted) by surveyed industries of Midcrest

Line no.	Industry of employment	No. of firms surveyed	Surveyed firms' employment	1960 Census employment, adjusted
2	Agriculture	5	17	10,062
5	Mining	2	34	82
6	Construction	26	88	1,222
11	Fabricated Metal Industries	3	74	11
12	Machinery except Electrical	1	5	159
16	Other Durable Goods	2	17	40
17	Food and Kindred Products	9	102	447
20	Apparel and Other Fabricated Textile Products	1	143	134
21	Printing, Publishing and Allied Products	7	57	229
23	Chemical and Allied Products	3	26	10
26	Wholesale Trade	22	130	739
27	Food and Dairy Products Stores	6	38	626
28	Eating and Drinking Places	9	101	747
30	Building Materials and Farm Equipment	69	235	505

Table 3. (continued)

Line no.	Industry of employment	No. of firms surveyed	Surveyed firms' employment	1960 Census employment, adjusted
31	Building Materials and Farm Equipment	69	235	505
32	Miscellaneous Retail Stores	56	215	616
33	General Merchandise and Other Retailers	17	96	723
36	Trucking Service and Warehousing	2	3	350
37	Other Transportation	2	3	115
38	Communications	1	9	202
39	Utilities and Sanitary Service	2	38	296
41	Finance, Insurance and Real Estate	2	19	532
44	Repair Services	16	28	436
46	Other Personal Services	2	3	441

or expanded very rapidly about 1960 but after the time of the Population Census. Alternatively it is possible that most of the employment of the industries was commuting from outside the area at the time of the 1960 Population Census and, thus, would not have been reported as being within the seven counties. The managers who answered the questionnaires would, of course, have reported the employees since they were not restricted in their answers by the location of residence of their employees. Perhaps most likely, however, is the possibility that a classification difference occurred. The writer classified industries using information presented on the questionnaire which described the nature of the products produced by the firm. One or more of the three firms so classified as Fabricated Metal Industries might have been classified as Machinery Except Electrical by the Census Bureau personnel for the 1960 census. This possibility is suggested by the fact that for Line 12 the survey picked up only one firm with five employees whereas the 1960 census shows 159 employees for that category. This probable difference in classification in this case was responsible for a decision at a later point to aggregate both survey and census data for a number of reported industries under the more general classification of Durable Goods before beginning other analysis of the data.

Table 1 shows the industries which were aggregated to form the Durable Goods category. Some of these industries were not sampled in the survey at all, but did have some employment reported in the 1960 Population Census. Such industries, identified as non-surveyed industries, are listed in Table 4 by line numbers, names of industries and corresponding census reported employment as of 1960. Tables 3 and 4 together exhaust the reported employment from Population Census sources. Table 3 shows some other interesting sidelights to the data problem. Line 20 is represented by one firm in the survey and was probably represented by one firm for the Population Census. The questionnaire respondent reported the same employment for 1960 as for 1963 which may account for the employment excess of the survey over the Population Census for Line 20. This difference could also occur because of incommuting or because of a dual job holding by some employees as a result of which the Population Census might classify an employee under some other industry whereas the questionnaire respondent would include all employees in his firm whether or not they held other jobs. Line 23 may be showing another case of differences in industrial classification since a firm classified by the writer as Chemical and Allied Products might have been placed in Other Nondurable Goods by the census classifier.

Table 3 also illustrates that, in employment terms, the various industries were sampled in vastly different degrees of a percentage of total employment for the respective industries.

A decision was made to use the survey data for the needed approximations for any industry for which the surveyed employment exceeded 25 employees. This decision was based on a desire

Table 4. 1960 Population Census reported employment (adjusted) by non-surveyed industries of Midcrest

Line no.	Industry of employment	1960 Population Census employment, adjusted
3	Forestry and Fisheries	4
9	Furniture and Lumber and Wood Products	21
10	Primary Metal Industries	0
13	Electrical Machinery, Equipment and Supplies	38
14	Motor Vehicles and Motor Vehicle Equipment	6
15	Transportation Equipment, except Motor Vehicle	8
19	Textile Mill Products	4
24	Other Non-Durable Goods	72
35	Railroad and Railway Express Service	342
43	Business Services	21
45	Private Households	611
47	Entertainment and Recreation Services	143
48	Hospitals	485
49	Education Services: Government	1,329

Table 4. (continued)

Line no.	Industry of employment	1960 Population Census employment, adjusted
50	Education Services: Private	506
51	Welfare, Religious and Non-Profit	236
52	Other Professional and Related Services	408
53	Public Administration	860
54	Industry Not Reported	0

to stretch the reliance on empirical data to the practical limit in order to give the model full opportunity to succeed or fail with the survey data that was available. The decision on data use is also associated with some special assumptions regarding the populations sampled and the cluster sampling procedure that was used.

The unit of observation in the Midcrest survey is the employee. A large number of populations were sampled. Each of these populations is equivalent to one of the industries listed in Table 3. For each of the industries of Table 3, as for all other industries in the area, the employees are gathered into clusters which we know as firms. The cluster sampling had to be used because individual employees would not have known what proportions of their time were spent in producing for export and the various categories of residentiary use. The person of the firm who could give such an answer for the sales of the firm was thereby giving the division of the time of each of the employees so that the total number of employees identified with each cluster that was sampled was included in the total sample for that industry. The decision to use surveyed data results for any industry for which the surveyed employment exceeded 25 must rest upon some special assumptions concerning the distribution of characteristics within and among clusters. It is possible for 25 employees to be included in just one cluster where the employment of a surveyed firm equals or exceeds 25, or the 25 employees might involve as many as 25 clusters if 25 firms of one employee each had been surveyed. If we assume that the mean value of a characteristic for a cluster approximates more and more closely the mean value of this characteristic for the industry as a whole as cluster size increases, then we have a basis for the use of the simple criterion that a sample of 25 employees is sufficient to generate some confidence in the surveyed data. If the 25 employees total is reached through summing the employees of several clusters, then we must assume that the mean of the clusters will approximate the mean of the industry population for each characteristic.

If the classification procedure of the standard industrial classification code consistently groups firms with similar export and residentiary outlet characteristics, and serious deviations from this similarity are found only among firms with very small employment, then we may place much reliance in the assumption that large clusters tend to have mean values approximating the mean of the population, and that this tendency strengthens very rapidly as the size of the cluster increases from one to 25 employees.

A qualification to the 25 employee minimum sample size was made by permitting industries which were represented by a smaller number of employees in this sample to be aggregated with related industries if such aggregation would provide a sample size greater than 25 employees. Related industries in this sense refers to industries which are each included in the same one of the major eight industries that are defined in the final matrix. The Durable Goods category identified by Line 8 is an aggregation of eight two-digit industries, only one of which, Line 11, had the required number of employees in the sample. Two others, Lines 12 and 16, had five and seventeen employees respectively in their samples. The other five were represented with small employment figures in the Population Census data but not at all in the survey data.

The goal of data analysis was to develop a transactions matrix for the Midcrest area using employment as a unit of economic activity and the Population Census employment totals as aggregate measures of economic activity of the area. Intermediate goals which could be classified as means toward achieving the final goal, were to use the survey data to the fullest extent possible in developing a transactions matrix, and to make the "best" possible estimates of the percentage division of transactions to firms, households and export for those sectors for which no survey data was usable or present.

"Best" in this context means the most nearly accurate approximation to percentage division values which would have been found if a complete survey had been conducted among the firms of these sectors. Tables 5, 6, 7 and 8 show progressive steps in the analysis of data and the generation of needed estimates. In Table 5 the surveyed industries are listed with the allocation of surveyed employment according to sales of firms to other firms of the area, households of the

Table 5. Allocation of surveyed employment, by industry, into groups represented by sales to all buyers, sales to area firms, sales to area households and sales to export

Line no.	Industry of employment	Surveyed employment alloted according to firms' sales to: All buyers	Area firms	Area households	Export
5	Mining	34.00	18.44	12.96	2.60
6	Construction	88.00	30.07	53.27	4.66
8	Durable Goods	96.00	5.50	1.98	88.52
17	Food and Kindred Products	102.00	13.65	10.80	77.55
18	Textile and Apparel Products	143.00	0.00	1.43	141.57
21	Printing, Publishing and Allied Products	57.00	39.30	11.15	6.55
22	Miscellaneous Non-Durables	26.00	10.60	0.00	15.40
26	Wholesale Trade	130.00	55.91	10.03	64.06
27	Food and Dairy Products Stores	38.00	0.94	32.32	4.74
28	Eating and Drinking Places	101.00	13.20	49.75	38.05
30	Building Materials and Farm Equipment	235.00	157.26	55.49	22.25
31	Automotive Dealers	329.00	133.41	149.83	45.76

Table 5. (continued)

Line no.	Industry of employment	Surveyed employment alloted according to firms' sales to: All buyers	Area firms	Area households	Export
32	Miscellaneous Retail	215.00	133.33	54.34	27.33
33	General Merchandise and Other Retailers	96.00	20.01	72.30	3.69

area and to exports. It should be made clear at this point that the information in Table 5 is, for each listed industry, a summation of the employment division by a comparable breakdown for each firm of that industry. Therefore, Table 5 itself represents an aggregation of the original data into a set of industries selected to minimize code classification errors, but, at the same time, avoid the combining of dissimilar industries at this point. The "All buyers" column of Table 5 lists a set of numbers which is identical to the numbers or combinations of some numbers in the column headed "Surveyed firms employment" of Table 3 for the industries which are listed in both tables. The new information of Table 5 is a breakdown of surveyed employment for each listed industry into the categories of sales to area firms, sales to area households and sales to exports. At a later point sales to firms are disaggregated further, but at this point data is being held in a form suitable for the generation of sector residentiary to total employment ratios. These ratios can be generated for all industries involved whether surveyed or non-surveyed. The SR/TE ratios for non-surveyed industries will be used at a later point as approximations of the input-output coefficients for the rows of the matrix represented by such industries or combinations of them. For the surveyed industries, individually generated ratios or coefficients will be available for most cells of the rows so that SR/TE ratios developed for such industries are useful only as comparison numbers to illustrate how much individually developed ratios might vary from the average for the industry as a whole.

Table 6 develops the information of Table 5 in percentage terms. For each industry the total surveyed employment is divided into sales to area firms, sales to area households and sales to exports according to the percent which each of these types of sales was of the total sales. The primary purpose of the percentages of Table 6 is for allocation of the census reported employment to sales to area firms, sales to area households and sales to exports. Before this is done, however, the percentage breakdown by industry can be inspected to see if there is some major departure from what might be expected to be the true situation in the area. For example, either a zero or a 100 percent entry in any of the columns might be suspect. Two zero entries occur, both of them among manufacturing industries. For Line 18 we can find zero percent sales to area firms from the industry Textile and Apparel Products. A knowledge of the area suggests that the entire industry in this area is represented by one firm which manufactures ladies lingerie and probably ships its total output outside the area except for a small quantity of goods sold directly to workers and which is represented by the one percent of sales to households.

For Line 22 the zero percent sales to households could be the result of the production of a chemical product not intended for sale to households. Some comments might be made on each

Table 6. Percentage of surveyed employment, by industry, represented by sales to all buyers, sales to area firms, sales to area households and sales to export

		Percentage allocation of surveyed employment according to firms' sales to			
Line no.	Industry of employment	All buyers	Area firms	Area households	Export
5	Mining	100.00	54.24	38.12	7.64
6	Construction	100.00	34.17	60.54	5.29
8	Durable Goods	100.00	5.73	2.06	92.21
17	Food and Kindred Products	100.00	13.38	10.59	76.03
18	Textile and Apparel Products	100.00	0.00	1.00	99.00
21	Printing, Publishing and Allied Products	100.00	68.95	19.56	11.49
22	Miscellaneous Non-Durable Goods	100.00	40.77	0.00	59.23
26	Wholesale Trade	100.00	43.01	7.71	49.28
27	Food and Dairy Products Stores	100.00	2.47	85.05	12.48
28	Eating and Drinking Places	100.00	13.07	49.26	37.67
30	Building Materials and Farm Equipment	100.00	66.92	23.61	9.47
31	Automotive Dealers and Service Stations	100.00	40.55	45.54	13.91

Table 6. (continued)

Line no.	Industry of employment	Percentage allocation of surveyed employment according to firms' sales to: All buyers	Area firms	Area households	Export
32	Miscellaneous Retail Stores	100.00	62.02	25.27	12.71
33	General Merchandise and Other Retailers	100.00	20.84	75.32	3.84

percentage breakdown observed for each industry of Table 6, but in general the conclusion of the writer is that there is no sufficient reason for attempting to adjust any of the observed percentages before applying them to the Population Census employment data. The writer has some suspicion that many of the eating and drinking places surveyed were located on main travel arteries or catered to tourist and traveling clientele and, thus, the export percentage of 37.67 percent may be somewhat high with respect to eating and drinking places in total in the area. However, there is no direct evidence that a non-representative sample was surveyed and so this export percentage is allowed to stand as it was computed.

5. Estimations for non-surveyed industries

Before proceeding directly into the presentation of estimates of activity division for non-surveyed industries, it is necessary to take a closer look at the definition of export activity. At an earlier point it was indicated that export activity has the essential characteristic of generating a flow of money into the area. Unfortunately, this simple definition does not cover adequately the problem of differentiating between export and residentiary activity when we look at the rich variety of forms of economic activity which becomes apparent through an industry inspection. A few examples may serve to illustrate this variety.

Workers in the Railway and Railway Express industry in an area such as Midcrest probably receive their paychecks from a central office in Chicago or some similar large metropolitan center. There appears to be an inflow of money in response to services rendered within the area by these railroad workers. Can we, therefore, say that all of the employment of the railroad transportation industry in Midcrest is export employment? The railroad workers, or at least some of them, are engaged a part of the time in assisting with the transportation of area produced products to locations outside the area. This latter activity might be called export. Some or all of the railroad workers are also engaged in the transportation of products into the area and the distribution of these products to various locations of the area. Such activity might more logically be considered as residentiary. A third type of activity involves assistance given within the area toward the cross-country transportation of products on trains moving through the area. Probably such activity would be considered as export. The money inflow characteristic for railroad workers is the same for each of these three types of activities though, tentatively, one of the activities has been classified as residentiary and the other two as export.

We might contrast the cases between independent and company-hired insurance agents. The independent agency and its associated agents perform services for clients in the area including the writing of policies for which they collect full premiums and retain a portion of this money while shipping the balance of the money to the insurance company home office which is located outside the area. The source of the earnings for the agency could be classified as residentiary. The company-hired agent under similar circumstances may collect checks which are made payable to the home office and will be submitted to it. The agent receives his earnings directly from the home office in the form of an inflow of money to the area. If we look only at the immediate source of the money, we could justifiably classify the company-hired agent as export, but the type of service he has performed is in no way different than that performed by the independent agent.

A lawyer may work on the settlement of an estate where the heirs of the estate all reside outside the area but the property of the estate is located in the area and the lawyer resides in the area. Ultimately the lawyer will receive a fee which will be a part of the estate, but his residentiary-export classification will depend on whether we consider his fee as coming from the heirs or from the estate itself.

A case similar to the lawyer example is that of the real estate agent engaged in selling property of a former resident who has moved outside the area. When the real estate agent collects his fee, it can be interpreted either as having come from the former owner who in effect sends his money back into the area from outside or it might be interpreted as having come from the buyer with the money coming from outside the area. It is necessary to make an almost arbitrary ruling about cases like this before any determination can be made regarding the classification of the real estate agent's work as either export or residentiary.

The entire agricultural industry is in a somewhat ambiguous position because it is possible in some areas for most of its output to go not directly into export but rather to move first to grain elevators, feed processors, packing plants, dairy plants, egg buyers and other wholesalers and partial processors of agricultural produce. A strict interpretation of the simple cash flow definition of the economic base would result in a classification of most farmers in such an area as indirect exporters which puts them into the category of residentiary employment. Such a classification strains the credibility of the export base rationale. Most interpreters of the scene would intuitively feel that the farmers were the basic suppliers of the agricultural produce of the area and that the wholesalers and processors of farm produce which are located in the area are there because of the availability of products on the farm.

Government services which are provided by state and federal government employees located in the area could be counted entirely as export employment if we looked only at the source of the paychecks of these employees. On the other hand, the money for their services can be interpreted as having been raised in the area through taxes and government collected fees, and having been only temporarily routed through a federal or state government system before being paid to the employees of the area. Alternately, a combination of these two interpretations can be employed.

The examples given above should illustrate adequately the difficulties that arise when the classification of all of the economic activity of the area is attempted in an export-residentiary sense. Obviously, even if funds and time were available, it would be impossible to complete the classification entirely by survey techniques. In several industries, special arbitrary decisions would still be needed to draw the line between export and residentiary determinations. In the following paragraphs an outline is given of a conceptual framework for resolving many of the difficulties outlined in the above examples. This framework agrees generally with interpretations used by other researchers, but there may be some additional interpretations which have not been presented previously.

In its very simplest terms economic base analysis attempts to describe the transactions which result when goods and services are supplied by employees of an area and demanded by firms and households located outside the area. In a money economy there is concurrently a reverse flow of money from firms and households outside the area to employees and households of the area. The confusions which result in trying to apply the simple "direction of money flow" criterion are a result of the specialization of functions which occurs in a society which is very highly developed in its transaction structure. One phase of this development is the creation of a great variety of institutions or mechanisms which are designed almost entirely to facilitate transactions activity among firms and households. These facilitating institutions at some point in the transactions process will actually have physical control of the product or of the money which is being transferred from person to person, person to firm or firm to person. The facilitating institution is often performing a service for both the supplier and the recipient of the product which is involved in the transaction. It cannot, however, be treated as the original or primary source of either the supply of or the demand for the product or the money which it handles. These institutions are primary suppliers only of the services of such things as assembly, disassembly, transporting, inventory management, accounting, communications and coordination.

At some levels of transactions facilitation it has been natural or easy for researchers and others to ignore the potential misinterpretation which might result from tracing all transactions to the finest detail. The fact that a farmer might receive a check from a packing company through the postal system would not in most cases cause us to credit the postal service with being the source of demand for the farmer's livestock. Nor would we usually give a local bank the honor of being the source of demand for the livestock simply because the farmer has to take this check to his bank in order to have an increased amount of money deposited in his own account. However, we might quite easily say that the livestock packing company was the source of demand for the farmer's product even though we know that the packing company does nothing more than change live animals into disassembled dead animals. Similarly, a grain elevator located in the nearest town might be called the source of demand for a farmer's grain which is sold off the farm even though the elevator is primarily an assembler of small lots of grain into large lots which are more convenient for transport out of the area.

Many more examples could be given to illustrate the problem that is created if we wish to distinguish between the "primary" sources of demand, the "primary" sources of supply and the types of activities which can be defined as facilitation of transactions. The situations where we may have various possible locations for payroll offices, various degrees of vertical integration, various degrees of horizontal integration and generally a variety of institutional arrangements for facilitating transactions all produce a potential source of confusion and ambiguity in the classification system for export and residentiary activity.

In order to make the export base analysis operational, it becomes necessary to look at what might be called the basic transaction, which in simple terms means the movement of goods or services between the supplier and the demander with all facilitating transactions stripped away. This latter definition might be a quite simple one in concept, but operationally it is necessary to define rather arbitrarily what constitutes a facilitating transaction. For the purposes of this study such a transaction is one in which more than 50 percent of the value of a good or service supplied to a recipient was previously purchased in substantially the same form from a previous supplier. This previous supplier must be identified as being of one industry. The transaction in which more than 50 percent of the value of the goods and services was previously purchased from a number of different industries does not qualify as a facilitating transaction unless at least one of these previous suppliers furnished more than 50 percent of the value.

Table 7 presents estimates of the percentage allocation of non-surveyed employment to categories of sales to area firms, sales to area households and sales to exports. The non-surveyed industries were untouched by the direct survey of firms for several reasons. The primary reason was the judgment that many entrepreneurs or administrators in these industries would have difficulty in differentiating between export and residentiary sales. Generally speaking, this would happen because of various types of facilitating transactions that intervene between the transfer of goods or services from the primary supplier to the primary source of demand. This latter situation could occur frequently in surveys of entrepreneurs and administrators in the industries of Agriculture, Government Education Services, Hospitals, Welfare, Religious and other Non-Profit Membership Organizations and Public Administration.

In the industry of Finance, Insurance and Real Estate,

Table 7. Estimated percentage allocation of employment of non-surveyed industries, by industry, represented by sales to all buyers, sales to area firms, sales to area households and sales to export

		Percentage allocation of non-surveyed employment according to estimates of firms' sales to			
Line no.	Industry of employment	All buyers	Area firms	Area households	Export
1	Agriculture and Related	100.00	0.00	6.00	94.00
35	Railroad and Railway Express Service	100.00	28.00	5.00	67.00
36	Trucking Service and Warehousing	100.00	45.00	5.00	50.00
37	Other Transportation	100.00	90.00	10.00	0.00
38	Communications	100.00	40.00	50.00	10.00
39	Utilities and Sanitary Service	100.00	40.00	60.00	0.00
41	Finance, Insurance and Real Estate	100.00	45.00	45.00	10.00
43	Business Services	100.00	100.00	0.00	0.00
44	Repair Services	100.00	50.00	50.00	0.00
45	Private Households	100.00	0.00	100.00	0.00
46	Other Personal Services	100.00	0.00	100.00	0.00
47	Entertainment and Recreation Services	100.00	0.00	80.00	20.00

Table 7. (Continued)

Line no.	Industry of employment	Percentage allocation of non-surveyed employment according to estimates of firms' sales to: All buyers	Area firms	Area households	Export
48	Hospitals	100.00	0.00	95.00	5.00
49	Education Services: Government	100.00	10.00	90.00	0.00
50	Education Services: Private	100.00	0.00	10.00	90.00
51	Welfare, Religious and Non-Profit	100.00	20.00	80.00	0.00
52	Other Professional and Related Services	100.00	40.00	50.00	10.00
53	Public Administration	100.00	40.00	40.00	20.00
55	Commuters Net Outflow	100.00	0.00	0.00	100.00

problems might have occurred in defining a transaction or a sale. Some industries such as Repair Services, Services to Private Households, and Other Personal Services were not surveyed because it was believed that there were negligible export activities among these sectors. Finally, the lack of sufficient resources of interviewer time and of money prevented efforts to design a more detailed and specific survey which might overcome some of the classification problems listed above.

Agriculture was believed to be very heavily oriented toward export activity. There was little interest, for this study, in tracing the within-Agriculture transactions. The buyers of agricultural produce who were located in the area were all to be treated as facilitators of transactions since in every case the agricultural produce purchased either for wholesaling or processing purposes was considered to be more than 50 percent of the value of products sold by these wholesalers or processors. Because of the conditions listed above, it was desirable to treat the entire industry of Agriculture and Related as one firm so as to subsume the farm-to-farm transactions.

The estimate of the residentiary activity by Agriculture was made through a macrocosmic technique. Data from the Economic Research Service, United States Department of Agriculture (49, p. 491) indicated that, in 1960, 36.2 percent of the farm labor used in the nation was engaged in the production of products which are indigenous to the Midcrest area. A comparable 36.2 percent of the Population Census reported total of employment in Agriculture in 1960 is equivalent to 1,540,937 persons employed in Agriculture in the United States. This latter figure is equal to 2.42 percent of the total employment of the United States for 1960 including employment in the armed forces. Under the assumptions of the macrocosmic technique we would assume 2.42 percent of the Midcrest employment would be needed in the production of agricultural produce for residentiary purposes in Midcrest. The carrying out of this calculation would produce a residentiary employment of 601.88 employees who were engaged in selling agricultural produce to households of the Midcrest area. This number represents almost 6 percent of the agricultural employment of Midcrest in 1960, and for Table 7 the estimated percentage allocation was made to equal exactly 6 percent in order to give a rounded number in keeping with other rounded percentages for this table. With 6 percent of agricultural employment devoted to residentiary sales to area households, and with an assumed zero percent devoted to sales to area firms, the residual of 94 percent becomes the agricultural employment devoted to sales to export.

All other sectors listed in Table 7 were analyzed through the use of as much information as the investigator possessed following a study of census reports which were disaggregated by counties and a number of informal visits with county extension personnel and leaders in the area who were involved in a series of seminar discussions related to the economic structure of the area. The percentage allocation estimates of Table 7 which were rounded to the nearest 5 percent, except for the first two estimates, were prepared by an iterative procedure in which each set of additional information was checked against previous estimates to indicate changes that might be needed. The following paragraphs present an overview of the considerations involved for most of the industries listed.

The industries of Private Households and Other Personal Services were assumed to be devoted entirely to residentiary sales to area households. These estimates might have been different if major recreational centers or convention centers had been located in the area, but such was not the case. Motel and hotel workers who were included in Other Personal Services should perhaps have been indicated as sales to area firms throgh the allocation of some of this percentage into this category. However, this would not have changed the makeup of the combined firms' and households' matrix. Motel and hotel services to salesmen are considered to be services to area firms since these firms actually furnish the income for the salesman operating in the area and are the source of demand for the salesmen in the area.

Railroad and Railway Express Service presented a considerable problem in this allocation procedure. Transcontinental rail service passes through the Midcrest area and, therefore, some of the employment must be considered export to the extent that it is devoted to the handling of through-shipments. The out-shipment of the products of agriculture and industry in the area is also an export activity. Within the area railroad services are used for the movement of imports from the area borders to wholesalers and in some cases to outlying towns. This activity is considered as residentiary. Finally, a small part of railroad activity might have been devoted to mail-order shipment and other shipments directed to households. The distribution of 28 percent to area firms, 5 percent to area households and 67 percent to export was the final result after considering the types of activity just mentioned. The industry of Trucking Service and Warehousing engages in activities very similar to those of the railway industry. The percentage allocation was shifted to place a heavier amount to area firms primarily because it was believed that trucking services were used much more in farm-to-farm movements and in shipments of goods to the smaller towns.

Other Transportation involves primarily bus and taxi services and airplane transportation. There was no evidence that any of these were export oriented to any noticable degree. Pipeline transportation is also included in the industry but the number of employees actually doing service work on the cross-country pipelines in the area was very small. The communications industry includes telephone and radio broadcasting services. The 10 percent export allocation for this industry presents primarily the service given by the telephone industry through long-distance calls involved in arranging for sale and processing of agricultural and manufacturing products of the area into export channels.

Utilities and Sanitary Service is considered to be entirely residentiary with the division into area firms sales, and area household sales being a rough estimate of the true situation. Finance, Insurance and Real Estate is considered to be primarily a residentiary industry with a 10 percent allocation to export to account for financial services and management services rendered within the area for persons living outside but owning property in the area, and for real estate sales services for the benefit of former residents of the area who are selling property located in the area.

Business Services were assumed to be entirely for the benefit of area firms. There was no evidence of any sizable business of this industry in the area which would have any clientele outside the area. Repair Services were found to be in a similar situation with a rough estimate of an even division of activity between sales to area firms and sales to area households and no export activity.

Entertainment and Recreation Services were estimated to be primarily for the benefit of area residents, although 20 percent of the activity was allocated to export to represent sales to out-of-area persons using state and county parks in the area. Hospitals were found to be primarily for the use of area residents with no major clinic or treatment facility that would attract large numbers of outside persons. Only 5 percent of the activity was designated as export, with the other 95 percent being allocated entirely to area households since members of the households are the source of demand for the service even though firms and insurance companies may pay a substantial part of some of the bills.

Government Education Services in the Midcrest area were represented almost entirely by public school systems of grade schools and high schools. Area households are assumed to be the recipients of the service to the extent that persons under 21 years of age are being educated. The 10 percent allocation to area firms represents the small part of Government Education Services that are devoted to adult education in topics related to operation of the firm in both the public schools and in the county extension service organizations. Private education services in this area are represented almost entirely by Graceland College at Lamoni. Estimates by persons familiar with the college and its enrollment indicated that approximately 90 percent of the persons enrolled were from outside the area. Therefore, 90 percent of this industry was designated as export and the other 10 percent as allocation to area households.

The industry of Other Professional and Related Services includes doctors, lawyers, nurses, engineers and a variety of others. There was general agreement among the persons contacted that most of these services were devoted to firms and households of the area with only a small amount, represented by the 10 percent allocation, devoted to export uses.

The Public Administration industry includes most government officials operating in the area and would normally be considered almost entirely residentiary. However, in most rural areas which are heavily engaged in the farming industry the number of federal agency officials is considerably higher as a percentage of the total employment than in non-rural areas. There seems to be justification for assuming that the higher employment is there because of a national interest in the task of assisting and regulating agricultural production. In this sense this additional increment of employment which can be identified by macrocosmic techniques can be considered as export. This line of reasoning is responsible for the allocation of 20 percent of the public administration employment to the export category for the Midcrest area.

The industry of Commuters Net Outflow has been previously defined as being an artificial industry for which the export allocation is assumed to be 100 percent. The methods and special assumptions used in measuring this commuter flow are described elsewhere in this report.

It should be emphasized at this point that the percentage allocations shown in Table 7 are in no sense a set of standard allocations that could be indiscriminately applied to comparable industries in other areas. For some industries of some areas the percentage sets might fit quite well, but for other industries and other areas the special conditions which were present in Midcrest might be missing and other special conditions not found in Midcrest might be present. For example, Private Education Services would not always be represented almost entirely by one privately owned college. Some other area might have a large employment in this industry but it would be made up entirely of church supported primary and secondary schools and the employment would thereby be almost entirely residentiary. Other areas might have hospitals or recreation services which do attract a large out-of-area clientele and would thereby be export oriented to a much larger degree. Some other area might have a much smaller amount of transcontinental railroad service in the Railroad and Railway Express industry. The set of percentages shown in Table 7 is rather highly specialized to the conditions of the Midcrest area, and there is no suggestion that these are generally the appropriate percentages for other areas.

On the other hand, the use of the same type of macrocosmic mathematics for the industry of Agriculture for other areas would likely produce a result very similar to that for Midcrest. Some other industries which are heavily oriented either to residentiary or export activities may well have the same heavy orientation toward one or the other in other areas. For this reason it might be possible to use the Table 7 percentages as a first approximation of estimations for other areas, but the fact that some estimations fit rather closely should not trap the user into believing that all of the estimates are good approximations for transfer from area to area. A special knowledge of the area being investigated is needed in order to uncover special conditions in the area and even to turn up unusual situations which may arise in the reporting of secondary data in census sources. One example of such an unusual situation occurred in the County Business Patterns publication for 1962 in which Adams County was shown to have one firm in the non-profit membership organization category which had an employment of more than 500 persons (40, p. 9). Personal acquaintance and knowledge of the area by the investigator made this report seem highly suspicious, and it seems virtually certain that the data reported reflects the location of the national office of the National Farmers Organization which prepares the payroll for all employees of the organization located everywhere in the United States. This particular item of data was, therefore, completely disregarded since it would have no value in an analysis of employment located in the area.

6. <u>Combining empirical data and census data</u>

Table 8 presents the final steps in the process leading to the breakdown of census reported employment into the categories of sales to area firms, sales to area households and sales to exports. Total adjusted census employment is reported in the "All buyers" column and is identical by industries to the numbers in the right-hand column of Table 3. The percentages shown in Table 7 are then used to allocate this total

Table 8. Allocation of adjusted census reported employment, by industry, by use of computed percentage distributions from surveyed industries and estimated percentage distributions from non-surveyed industries

		Adjusted census reported employment allocated according to firms' sales to			
Line no.	Industry of employment	All buyers	Area firms	Area households	Export
1	Agriculture and Related	10,062	0.00	603.72	9,458.28
5	Mining	82	44.48	31.26	6.26
6	Construction	1,222	417.56	739.80	64.64
8	Durable Goods	283	16.22	5.83	260.95
17	Food and Kindred Products	447	59.81	47.34	339.85
18	Textile and Apparel Products	138	0.00	1.38	136.62
21	Printing, Publishing and Allied Products	229	157.90	44.79	26.31
22	Miscellaneous Non-Durables	82	33.43	0.00	48.57
26	Wholesale Trade	739	317.84	56.98	364.18
27	Food and Dairy Products Stores	626	15.46	532.41	78.13
28	Eating and Drinking Places	747	97.63	367.97	281.40
30	Building Materials and Farm Equipment	505	337.94	119.23	47.82

Table 8. (continued)

Line no.	Industry of employment	Adjusted census reported employment allocated according to firms' sales to: All buyers	Area firms	Area households	Export
31	Automotive Dealers and Service Stations	721	292.37	328.34	100.29
32	Miscellaneous Retail Stores	616	328.04	155.66	78.30
33	General Merchandise and Other Retailers	723	150.67	544.57	27.76
35	Railroad and Railway Express Service	342	95.76	17.10	229.14
36	Trucking Service and Warehousing	350	157.50	17.50	175.00
37	Other Transportation	115	103.50	11.50	0.00
38	Communications	202	80.80	101.00	20.20
39	Utilities and Sanitary Services	296	118.40	117.60	0.00
41	Finance, Insurance and Real Estate	532	239.40	239.40	53.20
43	Business Services	21	21.00	0.00	0.00
44	Repair Services	436	218.00	218.00	0.00
45	Private Households	611	0.00	611.00	0.00
46	Other Personal Services	441	0.00	441.00	0.00

Table 8. (continued)

Line no.	Industry of employment	Adjusted census reported employment allocated according to firms' sales to: All buyers	Area firms	Area households	Export
47	Entertainment and Recreation Services	143	0.00	114.40	28.60
48	Hospitals	485	0.00	460.75	24.25
49	Education Services: Government	1,329	132.90	1,196.10	0.00
50	Education Services: Private	506	0.00	50.60	455.40
51	Welfare, Religious and Non-Profit	236	47.20	188.80	0.00
52	Other Professional and Related Services	408	163.20	204.00	40.80
53	Public Administration	860	344.00	344.00	172.00
55	Commuters Net Outflow	336			336.00

employment into the desired categories. As an illustration of the meaning of Table 8, we may look at Line 1. The information given indicates that in Agriculture and Related 603.72 employees earned their way through sales of agricultural products to households of the area and 9,458.28 employees earned their way through sales of products to export outside the area. Mining shows a somewhat different picture with 44.48 employees earning their way through sales to area firms, 31.26 earning their way through sales to area households, and only 6.26 employees earning their way through export sales.

In an input-output sense the numbers reported in Table 8 represent transactions information. The table is, of course, not a square transactions matrix since it has many more rows than columns. It would be possible to construct a simple 2 x 2 transactions matrix by collapsing all the rows into two rows, one representing firms and the other representing households. Such a formulation would be similar to the model presented earlier in which there existed two types of basic activity. However, this study is intended to be somewhat more disaggregated.

Up to the point of Table 8 there was one major advantage connected with keeping a high degree of disaggregation of industries. This advantage is related to the possibility that a serious error may have occurred in the generation of one or more of the percentage breakdowns as shown in Tables 6 and 7. Such an error could result from a biased sample in the survey for surveyed industries or from mistaken beliefs about sales activity by the writer in connection with non-surveyed industries. With surveyed industries the variable proportions of total employment sampled also made it possible that an error in a heavily sampled industry could seriously contaminate the percentage calculation of a more aggregated set of data of which it were a part. So long as the data was held in relatively disaggregated form, the types of errors just described would be isolated to the disaggregated industry involved, up to and including the calculations of Table 8. When the information of Table 8 is later collapsed, any biased result will be diluted by its commingling with other supposedly unbiased data. This entire argument, of course, loses legitimacy if sample bias and mistaken beliefs are encountered frequently and randomly throughout the disaggregated data analysis and estimation procedures.

For the purposes of testing the previously stated hypothesis it seems that a desirable midpoint must be found in the aggregation-disaggregation continuum. The stability of the SR/TE ratios which has been hypothesized is not likely to hold for a minute level of disaggregation. The differential characteristics, physical and cultural, of communities might easily cause instability of the SR/TE ratios in extremely disaggregated industry studies. For example, the existence of a locally oriented ski resort business in central Colorado with a ratio of one employee per 1,000 total employees in the area should not cause us to expect that ski resort employees in the same ratio to total employment would be found in the Clarion-Webster soil area of Iowa. Physical terrain conditions do not permit desirable ski resort operations in most of Iowa. However, it is possible that recreation services as a whole would show a relatively stable SR/TE ratio among various areas. The "psychological" need of the population for local recreation might be expressed more heavily in the purchase of ski resort services in Colorado and more heavily in the purchase of bowling alley services in central Iowa. In a similar vein, educational services may be provided almost exclusively by Education Services: Government in one area and almost exclusively by Education Services: Private in another area. The SR/TE ratio for education services in total could be relatively stable while on a more disaggregated basis such ratios would be violently unstable.

Extreme disaggregation of industries also introduces the problem of minimum community or area size, in population terms, for certain types of services. Hospital services, for example, may exist with a relatively stable SR/TE ratio in larger communities or areas down to about 25,000 population size. Below this population size, however, hospital services may or may not be present but, if not, are replaced partially by nursing home services which may appear in the category of Other Professional and Related Services. The examples presented above probably illustrate sufficiently the dangers of extreme disaggregation. The disadvantages must, of course, be balanced against the need for as much disaggregation as can be handled in order to provide a wider range of information concerning export activity and the specific industries in which it is found.

In the analysis of the data from the Midcrest area, aggregation of data was carried out to the point where only seven sectors or industries, plus the artificial industry of Commuters, are separately identified. The writer does not believe that the arguments of the preceding paragraphs would call for quite this much aggregation, but on the other hand the deficiencies in data and the stress on methodology rather than precise empirical results do not encourage a finer degree of disaggregation.

Table 9 is derived from Table 8 by collapsing the latter to the point where eight aggregated sectors or industries are left. The standard line number notation is still maintained so that it is possible to go from Table 9 to Table 1, if the reader wishes to determine which of the disaggregated industries are included in a specific listed industry of Table 9. In Table 9 the analysis of the data and the estimates has been carried to the point where it is now possible to use the numbers in the columns headed "Area firms" and Area households" for the generation of quotients which can be used to form SR/TE ratios.

What is needed at this point is a number for each of the listed industries which will describe how much output is

Table 9. Allocation of adjusted census reported employment, by aggregated industries, to categories of sales to area firms, sales to area households, sales to exports and sales to all buyers

Line no.	Industry of employment	Adjusted census reported employment allocated according to firms' sales to: Area firms	Area households	Export	All buyers
1	Agriculture and Related	0.00	603.72	9,458.29	10,062.00
4	Construction and Related	462.04	771.06	70.90	1,304.00
7	Manufacturing and Related	267.36	99.34	812.30	1,179.00
25	Trade, Wholesale-Retail	1,593.96	2,105.16	977.88	4,677.00
34	Transportation and Related	555.96	324.70	424.34	1,305.00
40	Finance and Related	239.40	239.40	53.20	532.00
42	Services and Related	926.30	3,828.65	721.05	5,476.00
55	Commuters Net Outflow	0.00	0.00	336.00	336.00
	All Industries	4,045.02	7,972.03	12,853.95	24,871.00

transferred to area firms per unit of output of all area firms. The output of area firms in employment terms is described by the number 24,535, which represents the total of job holding employees residing in the area minus the net number of these employees who commute out of the area to work. In other words, the output of Midcrest area firms is given by the equation 24,871 minus 336 equals 24,535. This latter number is divided into each of the numbers of the "Area firms" column of Table 9 in order to form one-half of the quotients which we need for the SR/TE ratios.

Area households will be represented by the number 24,871, which is the Population Census reported number for total employment residing in the area. This number may not, of course, represent the number of actual households in the area. What is wanted here is a measure of consumer demand which, in employment terms, will be reasonably comparable among areas. It might be said that we are trying here to form a sector residentiary to total consumption ratio with the purpose of using this ratio in a number of areas and that any source of a number for the denominator which gives realistic results among the areas will be satisfactory. The number of total residing employees in an area is assumed to be such a satisfactory number.

The number 24,871, will be divided into each of the numbers in the "Area households" column of Table 9 to form the other one-half of the quotients which are needed for the SR/TE ratios. The mathematical operations just described can be set up in matrix notation as follows:

$$\begin{bmatrix} 0.00 & 603.72 \\ 462.04 & 771.06 \\ 267.36 & 99.34 \\ 1593.96 & 2105.16 \\ 555.96 & 324.70 \\ 239.40 & 239.40 \\ 926.30 & 3828.65 \\ 0.00 & 0.00 \end{bmatrix} \begin{bmatrix} \frac{1}{24,535} & 0 \\ 0 & \frac{1}{24,871} \end{bmatrix}$$

$$= \begin{bmatrix} 0.00 & 0.02427 \\ 0.01883 & 0.03100 \\ 0.01090 & 0.00399 \\ 0.06497 & 0.08464 \\ 0.02266 & 0.01306 \\ 0.00975 & 0.00963 \\ 0.03775 & 0.15394 \\ 0.00 & 0.00 \end{bmatrix}$$

The first left-hand matrix above includes the two columns from Table 9 which are labeled "Area firms" and "Area households." This matrix is postmultiplied by the matrix to its right which is so designed as to provide the wanted quotients. The matrix to the right of the equal sign provides two columns of quotients. A given number in the left-hand column is the number which describes how much output of its industry is needed for each unit of output of all area firms. A given number in the right-hand column describes the amount of output of the appropriate industry which is needed for each unit of consumption demand for area produced products by area households. If these two columns of the matrix to the right of the equality sign are described as column vectors, we may define the sum of these two vectors as the vector of SR/TE ratios for the eight aggregated industries where the ratios are in order from top to bottom corresponding to the top to bottom order of industries as listed in Table 9.

The sum of the vectors and the attachment of the elements of the resulting vector to the appropriate industries is shown in Table 10.

Few special comments are needed in regard to Table 10 beyond what has been said before. The ratios as they stand are specific to the Midcrest area for the relationships existing in 1960. The industry "Trade, Wholesale-Retail" has, as might be expected, a relatively high ratio which is exceeded only by that of "Services and Related". The industry "Commuters Net Outflow" has a zero value for the ratio in keeping with the assumption that employment in this sector is in response to demand from outside the area and has no relationship to total employment residing in the area.

The SR/TE ratios for the industries represented by Lines 1, 34, 40, 42 and 55 become the sector residentiary to sector total ratios in the transactions matrix. The data analysis for these sectors has, thus, been completed. The remaining data analysis is related almost entirely to the sectors represented by Lines 4, 7 and 25, the industries on which the area survey was concentrated. The SR/TE ratios for these latter industries are not used directly in the final matrix development. However, these ratios are still of interest in order to illustrate the divergence from the weighted averages of the

Table 10. Sector residentiary to total employment ratios, by industry

Line no.	Industry of employment	SR/TE ratio
1	Agriculture and Related	0.02427
4	Construction and Related	0.04983
7	Manufacturing and Related	0.01489
25	Trade, Wholesale-Retail	0.14961
34	Transportation and Related	0.03572
40	Finance and Related	0.01938
42	Services and Related	0.19169
55	Commuters Net Outflow	0.00000

specific sector ratios given by Table 10. Table 11 presents the maximum of transactions information that can be derived from the survey data for the aggregated industries which are used to make up the final transactions matrix. Table 11 reports only on the industries of Construction and Related, Manufacturing and Related and Wholesale-Retail Trade. For these it disaggregates the allocation of sales to area firms into the categories of sales to Agriculture and Related area firms, sales to Construction and Related area firms, sales to Manufacturing and Related area firms, sales to Wholesale-Retail area firms and sales to all other firms of the area.

With the information of Table 11, sector-to-sector ratios can be formed in a manner equivalent to that used for the formation of the quotients which were used to form the SR/TE ratios. Each number of the "Agric." column is divided by the total adjusted reported employment of Agriculture and Related, in this case 10,062. Similarly, each of the other columns is divided through respectively by the total employment of the industry identified with the column. The division operation on all columns is shown, again in matrix form, as follows:

$$\text{Let} \quad \begin{bmatrix} 338.06 & 15.17 & 5.76 & 63.93 & 39.12 \\ 60.71 & 2.07 & 9.36 & 186.55 & 8.67 \\ 1095.41 & 58.02 & 19.29 & 318.32 & 102.92 \end{bmatrix} = [G]$$

Let

$$\begin{bmatrix} \frac{1}{10,062} & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{1304} & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{1179} & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{4677} & 0 \\ 0 & 0 & 0 & 0 & \frac{1}{7313} \end{bmatrix} = [H]$$

Then

$$[G][H] = \begin{bmatrix} 0.03360 & 0.01163 & 0.00489 & 0.01367 & 0.00535 \\ 0.00603 & 0.00159 & 0.00794 & 0.03989 & 0.00119 \\ 0.10887 & 0.04449 & 0.01636 & 0.06806 & 0.01407 \end{bmatrix}$$

The completed matrix arithmetic gives us a part of the final matrix of technology coefficients which are needed for a testing of the model. Specifically, this is a part of the firm-to-firm matrix that was earlier designated as $[{}^{A}f]$. For the full matrix, a set of numbers which will complete eight rows and eight columns is needed. This latter requirement exists for both the firm-to-firm matrix and for the firm-to-household matrix previously designated as $[{}^{A}h]$. Mathematically, the simplest method of generating an 8 x 8 matrix is to duplicate missing columns from columns already existing. For example, the right-hand column of the partial $[{}^{A}f]$ matrix can be expanded into three columns. In doing this we are, in effect, saying that the technology coefficients associated with the three buying industries are identical to the coefficient that is appropriate

Table 11. Allocation of adjusted census reported employment, by aggregated industries to categories represented by sales to selected industries

	Adjusted census reported employment allocated according to sales to buying industries identified in abbreviated form as				
Selling industry	Agriculture	Construction	Manufacturing	Trade	Other
Construction	338.06	15.17	5.76	63.93	39.12
Manufacturing	60.71	2.07	9.36	186.55	8.67
Trade	1,095.41	58.02	19.29	318.32	102.92

when these three buying industries are considered as buyers in aggregate.

Similar reasoning will allow us to generate seven partial columns for the $[{}^{A}f]$ matrix by repeating the bottom four numbers of the left-hand vector of the previously derived quotients matrix. The top number of this vector can also be repeated to give an Agriculture and Related row, and the firm-to-firm matrix is, thus, completed and appears as shown in Figure 2.

Figure 2 gives the matrix $[{}^{A}f]$, which includes the portions of the technology coefficients which represent area firms to area firms transactions in employment terms. The area firms to area households matrix is formed by expanding the right-hand vector of the quotients matrix into eight columns. This is permitted by assuming that employees on the average exhibit the same consumption demand through households regardless of the industries in which they may work. This latter assumption is almost certainly not true, but insufficient information is available to justify the estimation of differentials which are sufficient in magnitude to substantially affect the operation of the model. In effect, income differences of employees among sectors within the area are being assumed away as important influences on consumption spending patterns for products of the area. Figure 3 gives the firms to households technology matrix.

It may be noted that all columns of the firms to households matrix are identical whereas in the firms to firms matrix the

	Agric.	Constr.	Manuf.	Trade	Trans.	Finance	Services	Commuters
Agric.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Constr.	0.03360	0.01163	0.00489	0.01367	0.00535	0.00535	0.00535	0.00000
Manuf.	0.00603	0.00159	0.00794	0.03989	0.00119	0.00119	0.00119	0.00000
Trade	0.01887	0.04449	0.01536	0.06806	0.01407	0.01407	0.01407	0.00000
Trans.	0.02266	0.02266	0.02266	0.02266	0.02266	0.02266	0.02266	0.00000
Finance	0.00975	0.00975	0.00975	0.00975	0.00975	0.00975	0.00975	0.00000
Services	0.03775	0.03775	0.03775	0.03775	0.03775	0.03775	0.03775	0.00000
Commuters	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Figure 2. Matrix of technology coefficients representing firms to firms transactions among industries identified by column and row abbreviated designations

	Agric.	Constr.	Manuf.	Trade	Trans.	Finance	Services	Commuters
Agric.	0.02927	0.02927	0.02927	0.02927	0.02927	0.02927	0.02927	0.02927
Constr.	0.03100	0.03100	0.03100	0.03100	0.03100	0.03100	0.03100	0.03100
Manuf.	0.00399	0.00399	0.00399	0.00399	0.00399	0.00399	0.00399	0.00399
Trade	0.08464	0.08464	0.08464	0.08464	0.08464	0.08464	0.08464	0.08464
Trans.	0.01306	0.01306	0.01306	0.01306	0.01306	0.01306	0.01306	0.01306
Finance	0.00963	0.00963	0.00963	0.00963	0.00963	0.00963	0.00963	0.00963
Services	0.15394	0.15394	0.15394	0.15394	0.15394	0.15394	0.15394	0.15394
Commuters	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Figure 3. Matrix of technology coefficients representing firms to households transactions among industries identified by column and row abbreviated designations.

right-hand column is composed entirely of zero elements even for elements of rows which are otherwise themselves composed of identical elements. This condition reflects the fact that commuters are not defined as an internal firm and, therefore, cannot be the recipients of firms to firms transactions. On the other hand, commuters are a part of households and a part of consumption demand in the area and, therefore, are given the same firms to households coefficients as other employees who hold jobs within the area.

The matrix which is of interest for testing at later points is the total matrix, $[A_t]$, defined previously as $[A_f]$ plus $[A_h]$. $[A_t]$ in expanded form is shown in Figure 4.

The matrix $[A_t]$ has been so constructed that it can be postmultiplied by a vector, (X), whose elements give the total employments for eight aggregated sectors of Midcrest and the resulting vector from the multiplication will give the domestic employments of these eight sectors. If this domestic export vector is then subtracted from the total employment vector, the result will be a vector of export employments, (Y), for the eight sectors. This entire operation is described in matrix notation as $(Y) = (X) - (AX)$. It is the above type of mathematical operation that we wish to apply to other areas where the total employment vector, (X), is known from census data.

In previous discussion it has been indicated that the

	Agric.	Constr.	Manuf.	Trade	Trans.	Finance	Services	Commuters
Agric.	0.02427	0.02427	0.02427	0.02427	0.02427	0.02427	0.02427	0.02427
Constr.	0.06460	0.04263	0.03589	0.04467	0.03635	0.03635	0.03635	0.03100
Manuf.	0.01002	0.00558	0.01193	0.04388	0.00518	0.00518	0.00518	0.00399
Trade	0.19351	0.12913	0.10100	0.15270	0.09871	0.09871	0.09871	0.08464
Trans.	0.03572	0.03572	0.03572	0.03572	0.03572	0.03572	0.03572	0.01306
Finance	0.01938	0.01938	0.01938	0.01938	0.01938	0.01938	0.01938	0.00963
Services	0.19169	0.19169	0.19169	0.19169	0.19169	0.19169	0.19169	0.15394
Commuters	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Figure 4. Matrix of technology coefficients representing sum of firms to firms and firms to households transactions among industries identified by column and row abbreviated designations.

matrix $[A_t]$ probably cannot be transferred indiscriminately to other areas of different sizes, and other differential characteristics, and for different points in time.

For the present we are not interested in using the matrix for points in time other than 1960, so adjustments for time differences need not concern us here. Income level and income distribution characteristics may affect the transferability of the matrix, but for the present these possibilities also will be ignored, particularly as the matrix is being tested in geographical areas close to the Southern Iowa area in which it was developed.

The rationale behind the need for adjustments of the matrix in response to area size differences rests upon the observed fact that very large economies, say an economy the size of the United States, appear to engage primarily in residentiary activity. Conversely, very small economies, for example, individual families, appear to engage primarily in export activities. In quite simple terms, the family sells almost all its output to buyers outside the family whereas the nation sells almost all its output to itself. Any given technology matrix cannot possibly describe economies of both extremes of size nor can it probably describe any more than a narrow range of economy sizes anywhere between the extremes.

If observations of transactions had been obtained for areas of two or more sizes, it might have been possible to generate workable adjustment factors and techniques which when applied to a standard matrix, would have given a close approximation to the observed technology matrix for each of the areas observed. However, at this point the only data for other nearby areas that is known to the writer is for individual industries within the overall category of Manufacturing and Related, and for these industries the point in time is not identical to the year 1960 which was used for the Midcrest matrix development. It is true that some derived estimates are available from other studies in other states, but most, if not all, of these sets of data were generated by the macrocosmic methods which in a sense this study is attempting to avoid. Thus, it would be inconsistent to use any such data sources as primary information for this study.

We may, however, stay close to the spirit and the general degree of rigor and assumptions framework of macrocosmic studies by relating the Midcrest matrix to the national economy for 1960 and attempt to determine what modifications would be needed to generate an adjusted matrix that would describe the desired degree of residentiary activity for the national economy for that year. Two basic operations are needed in order to make the desired comparison. We must see how much domestic employment is calculated for each industry when we postmultiply the Midcrest matrix by the vector of U. S. employment by industries for 1960, and compare this vector with an estimated vector of residentiary employment by sectors as it is believed to have actually existed for 1960.

Table 12 gives the information on adjusted census reported employment for 1960 for the United States by the eight aggregated industries for which the technology matrix has been constructed. The adjustments for the United States' employment, from that reported in the 1960 Population Census (44, p. 221) involved only the allocation of Industry Not Reported numbers to the other sectors. It is assumed for the nation at large that the net number of commuters is zero, and so the Commuters Net Outflow entry in the column is zero. The second column of Table 12 shows the domestic employment that is calculated for each of the eight industries when the Midcrest matrix is used without adjustment of any rows or columns or of any of the individual elements of the matrix. The third column shows the export employment of the United States as the mathematical relationships would describe it if we assumed that the Midcrest matrix could be used for areas of any size without being first adjusted. It must be emphasized that this is a spurious column of export employment which is reproduced in Table 12 only to indicate, in the extreme size case, the need for a technology matrix adjustment method. It seems reasonable to assume that most knowledgeable observers of United States export versus residentiary activity would conclude that this calculated export column greatly overmagnifies the amount of the export activity for each of the sectors.

If a somewhat crude approximation to the export and residentiary employment picture of the United States were satisfac-

Table 12. Total United States employment, illustrative residentiary employment, and illustrative export employment, 1960, by industry, using unadjusted Midcrest matrix to illustrate unrealistic results

Industry of employment	Adjusted total employment	Illustrative residentiary employment	Illustrative export employment
Agriculture and Related	4,532,773	1,568,795	2,963,978
Construction and Related	4,657,882	2,600,784	2,057,098
Manufacturing and Related	18,249,419	957,380	17,292,039
Trade, Wholesale-Retail	12,288,453	7,657,184	4,631,269
Transportation and Related	4,645,590	2,308,914	2,336,676
Finance and Related	2,807,925	1,252,709	1,555,216
Services and Related	17,457,205	12,390,697	5,066,508
Commuters, Net Outflow	0	0	0
All Industries	64,639,247	28,736,463	35,902,784

tory, we might simply assume that all United States economic activity was residentiary. However, the writer felt that a somewhat more realistic approach might be made by attempting to determine more closely the less than complete residentiary orientation of each of the industries. Several sources of export information were studied in order to attempt an approximation of United States employment that could be considered export in the same sense that Midcrest employment was considered export with respect to its area. The only data found which reported export activity for all of the industries in one source was in the transactions table of the 1958 input-output study by the National Economics Division Staff as reported in the Survey of Current Business, September, 1965, issue (30). This table reports exports as well as other activity in total sales terms rather than in employment terms. Some conversion technique must, therefore, be used to determine percentages by which industry employments are to be considered either export or residentiary. The simplest technique is to assume that employment in each industry can be divided up proportionately the same as total sales are divided. With this assumption the percentage that net exports are of total output in the input-output table would be considered as the percentage that export employment is of total employment for the particular industry. This is not quite the same assumption as was used in the Midcrest study. In the latter case, employment was divided proportionately the same as sales for each individual firm were divided. The conversion from sales to employment terms was made at the firm level in Midcrest whereas with the national data the conversion is being made at the industry level.

The condensation of data from the interindustry transactions 1958 table is shown in Table 13. The footnotes of Table 13 explain the adjustments that were made to the data of the interindustry transactions table. The "Percent residentiary" column of Table 13 provides in a sense a target set of percentages. They are targets in the sense that the ideal adjusted matrix of technological coefficients in employment terms for the 1960 United States economy should provide a set of residentiary employment numbers that, by industries as listed in Table 12 and 13, could be converted into the target percentages of Table 13. An inspection of Table 12 will suggest that the residentiary employment vector generated by using the unadjusted matrix missed by a wide margin the values needed to generate the target set of percentages.

The one simple method of reaching the target percentages is to determine a set of target residentiary employments corresponding to these percentages and then determine by how much the unadjusted matrix residentiary employment for each sector must be multiplied in order to equal the target residentiary area employment for that sector. Information of this type is presented in Table 14. The left column of numbers is identical to the middle column of Table 12. The middle column of Table 14 is the set of target employments that corresponds to

Table 13. Total demand, export final demand, percent export and percent residentiary, by industry, derived from 1958 interindustry transactions data for the United States (in millions of dollars at producers prices)

Industry of employment	Total demand	Export final demand	Percent export	Percent residentiary
Agriculture and Related	62,732	1,404[a]	2.66	97.34
Construction and Related	87,646	485	0.55	99.45
Manufacturing and Related	356,881	11,999	3.36	96.64
Trade, Wholesale-Retail	95,250	1,420	1.49	98.51
Transportation and Related	65,249	2,409	3.69	96.31
Finance and Related	88,410	1,278[b]	1.45	98.55
Services and Related	87,076	1,611[b]	1.85	98.15
Commuters Net Outflow	0	0	0.00	0.00
All Industries	833,244	20,606	2.47	97.53

[a]A reported export final demand of 1,884 million dollars was reduced approximately 25 percent in order to avoid counting donated foreign aid as normal exports.

[b]1,000 million dollars was added to each of Finance and Related and Services and Related to represent services of U. S. residing employees devoted to management of U. S. investments in foreign lands and services rendered to foreign tourists.

Table 14. Unadjusted residentiary employment, target residentiary employment, and required unadjusted sector residentiary multiplier, by industry, for United States, 1960

Industry of employment	Unadjusted residentiary employment	Target residentiary employment	Sector residentiary multiplier
Agriculture and Related	1,568,795	4,412,201	2.8125
Construction and Related	2,600,784	4,632,264	1.7811
Manufacturing and Related	957,380	17,636,239	18.4214
Trade, Wholesale-Retail	7,657,184	12,105,355	1.5809
Transportation and Related	2,308,914	4,474,168	1.9378
Finance and Related	1,252,709	2,767,210	2.2090
Services and Related	12,390,697	17,134,247	1.3828
Commuters Net Outflow	0	0	0

the set of target percentages which were listed in the far right-hand column of Table 13. The sector residentiary multipliers were generated by dividing the target residentiary employment by the unadjusted residentiary employment for each industry respectively. If the sector residentiary multipliers are placed consecutively down the diagonal positions of a diagonal matrix, such a diagonal matrix could be postmultiplied by the unadjusted coefficient matrix, and the result would be an adjusted coefficient matrix which would yield the set of target residentiary employments when postmultiplied by the vector of total employments by industries. Alternately, the original calculation could use the unadjusted matrix to yield the vector of unadjusted residentiary employments. This latter vector could then be premultiplied by the diagonal matrix of multipliers to yield the vector of target residentiary employments.

The set of multipliers which has been determined for the national economy is really a set of upper limits for these multipliers. We will not be interested in this upper limit multiplier set in any calculation on area export levels by industries, but rather we will want some value between 1.0 and the upper limit value for each of the multipliers and this value should increase monotonically as the size of the area, measured in employment terms, increases up to the limit of the employment of the United States in 1960. Another direction of change may have to be considered for this multiplier. The value of 1.0 is appropriate for an area the size of the Midcrest area in employment terms in 1960. For convenience, we will assume that the multiplier value should be 1.0 for an employment of 25,000. In so doing we are rounding off the actual reported employment in Midcrest of 24,871. Now presumably an area with no employment should have an adjustment multiplier of zero or at least zero should be the lower limit as the area becomes progressively smaller. Thus, for each adjustment multiplier we have a lower limit of zero, a value of 1.0 at the employment of 25,000 and an upper limit as given from the appropriate row of the right-hand column of Table 14. We must turn next to what is essentially a mathematical problem in determining a reasonable function or combination of functions for describing the changing of values of the adjustment multipliers when employment is used as an independent variable in these functions. If we designate the adjustment multiplier of industry i as M_i, the employment of an area as X and the upper limit of the value of the multiplier for industry i as U_i, we may set up the requirements for the function as follows:

$M_i = M_i(X)$,

$M_i(X) = 0$ when $X = 0$,

$M_i(X) = 1$ when $X = 25{,}000$,

$M_i(X) = U_i$ when $X = 64{,}639{,}247$,

$\frac{dM_i}{dX} > 0$ for $0 < X \leq 64{,}639{,}247$ and

$$\frac{d^2M_i}{dX^2} < 0 \text{ for } 0 < X \leq 64{,}639{,}247.$$

The requirement that the first derivative of M_i with respect to X be positive insures that each multiplier will increase monotonically as X increases through the range specified. The requirement that the second derivative of M_i with respect to X be negative insures that each multiplier will increase at a decreasing rate as X increases through the range specified.

The latter condition is actually a result of the prior conditions. It would be impossible for M_i to increase monotonically at a constant or increasing rate in response to the range of values specified for X and simultaneously pass through the M_i values of 0, 1, and any one of the upper limits previously specified. More than that, however, the effect of a decreasing rate of increase of the multiplier in economic terms is that import substitution is presumed to occur most rapidly as area size increases from the very lowest level of absolute size and occur least rapidly as area size approaches the size of the nation. In the latter case it is assumed that most of the possible import substitution has occurred by the time an area reaches the size of a region comparable to 10 to 12 contiguous states.

A relatively simple function which can fulfill the requirements is of the form:

$M = (bX)^q$

It can be shown that the above function will take on the required values as follows:

$(bX)^q = 0$ when $X = 0$ no matter what values b and q may have.

$(bX)^q = 1$ when $X = 25{,}000$ provided $b = (25{,}000)^{-1}$ and q has any value whatsoever.

$(bX)^q = U_i$ when $X = 64{,}639{,}247$, $b = (25{,}000)^{-1}$ and q has the unique value which will produce $(bX)^q = U_i$.

$$\frac{dM}{dX} = bq(bX)^{q-1} > 0 \text{ whenever } q,\ b,\ X > 0$$

$$\frac{d^2M}{dX^2} = b^2q(q-1)(bX)^{q-2} < 0 \text{ whenever } 0 < q < 1$$

Since X will range over the values from 0 to 64,639,247, and there is nothing to stop us from setting b equal to $(25{,}000)^{-1}$, the only unknown is the value for q that will produce $\left[(25{,}000)^{-1}\ (64{,}639{,}247)\right]^q = U_i$. There will, of course, be a unique q for each industry since each has a unique upper limit multiplier value. If each of the q's is greater than zero but less than one, all of the required conditions will have been met.

If we designate q_i as the value of q for industry i, the unique value of each q may be determined by setting up the following logarithmic function:

$q_i \log \left[(25,000)^{-1} (64,639,247) \right] = \log U_i$, and solving for q_i.

Using the previously designated reference line number as the values for i, the calculated values for the q_i's are the following:

$q_1 = 0.13160$	1 = Agriculture and Related
$q_4 = 0.07345$	4 = Construction and Related
$q_7 = 0.37078$	7 = Manufacturing and Related
$q_{25} = 0.05829$	25 = Trade, Wholesale-Retail
$q_{34} = 0.08419$	34 = Transportation and Related
$q_{40} = 0.10086$	40 = Finance and Related
$q_{42} = 0.04122$	42 = Services and Related

All q values lie within the required limits. The function has met all required conditions which have been specified up to this point.

When the function is used to solve for the value of an adjustment multiplier, the solution will be for a given industry of a given area. The industry identification will determine which of the above q values will be entered as the exponent, and the total employment of the area will be entered as the value of X. The coefficient, b, is always equal to $(25,000)^{-1}$ so only M_i is left as an unknown for which we can obtain a unique solution.

The function $M = (bX)^q$, is the simplest non-linear form which behaves as desired in a qualitative sense. There is no assurance, however, that the function will produce adjustment multiplier values which are reasonable quantitative approximations of the true adjustment multipliers when area employment is anything other than zero, 25,000 or 64,639,247. Unfortunately, we can only estimate the value of the export data for other areas, and as a result the judgments concerning desired multiplier values are also estimates.

Without question, however, a failure of the adjustment multiplier function can be suspected when its use produces a negative element in the export vector in a case where the unadjusted matrix does not produce such a negative element.

In a preliminary testing of the adjustment multiplier function with 1960 employment data from several areas a number of cases of negative export elements did occur. The multiplier value did not decrease rapidly enough as the employment level decreased below 25,000, and it increased too rapidly as the employment level increased above 25,000. A dampening effect was needed to make the adjustment multiplier formula produce reasonable results.

The greatest degree of dampening would be represented by one linear function relating M_i to X between X values of 0 and 25,000 and a second linear function relating M_i to X between

X values of 25,000 and 64,639,247. The first linear function must equal zero when X equals zero and equal 1 when X equals 25,000. The function $M_i = (25,000)^{-1} X$ will meet the requirements. The second linear function must equal 1 when X equals 25,000 and equal the upper limit of the multiplier for a particular industry when X equals 64,639,247. The function $M_i = 1 + r_i\ (X-25,000)$ will meet the requirements provided $r_i = (U_i - 1)\ (64,613,247)^{-1}$.

The linear functions each have a positive first derivative, but since they are linear each has a zero second derivative. In a sense, therefore, the combination of the linear functions represents the limit of the dampening that can be applied to a quadratic function having positive first and second derivatives and with required values for the function at three points.

The final adjustment multiplier is of the form:

$$M_i = c \left[(25,000)^{-1}X \right]^q + d \left[(25,000)^{-1}X \right] \text{ for } X \leq 25,000$$

$$M_i = c \left[(25,000)^{-1}X \right]^q + d \left[1 + r_i(X-25,000) \right] \text{ for } X \geq 25,000$$

and $c + d = 1$, $c > 0$, $d > 0$.

The above formulation permits a weighted averaging of the quadratic function with the appropriate linear function, and in this process the dampening effect is obtained. In the area export calculations presented later the values, $c = 0.75$ and $d = 0.25$ were used. There is no "magic" inherent in these particular weights other than the fact that they appeared to work.

7. Commuting estimate procedure

The artificial industry of Commuters Net Outflow enters into the analysis because of differential effects of employment upon an area's economy depending upon whether or not the employee resides inside or outside the area. The employee who both resides and works in the area is presumed to have an effect on both the firms to firms and firms to households transactions matrices. The employee who resides in the area but works outside the area is presumed to have an affect only on the firms to households transactions matrix of the area. The employee who works in the area but resides outside the area is presumed to have an effect only on the firms to firms transactions matrix of the area.

If the analysis of areas could be conducted with pure examples of functional economic areas, the commuting industry could safely be assumed to have zero employment. This would be so because functional economic areas have been assumed to be, among other things, self-contained labor market areas. Unfortunately, boundary lines which must be accepted for empirical analysis may not match the natural boundary lines of functional economic areas. This can happen because data is available only by county units and the functional economic area line may cross through the counties. It may happen because there is a demand for information to describe relationships for a single county even though it is well recognized that this county is only a part of a much larger functional economic area.

The analysis of partial functional economic areas may occur at state boundaries where, for example, the central city lies on the boundary or immediately adjacent to it. Very heavy commuting movements may occur in such a case. Representative examples for Iowa are the boundary city locations of Davenport, Council Bluffs, Sioux City and Dubuque.

For simplicity and convenience, the Commuters Net Outflow industry was created for which the measurement of employment would be positive when the number of out-commuters exceeded the number of in-commuters, and would be negative if the reverse situation occurred. Form a mathematicl standpoint, this treatment of commuters as a homogeneous group is satisfactory so long as the consumption demands of households are identical for all the industries of actual employment of the breadwinners;

The major problem in the handling of the commuting industry is the existence of a serious gap in the set of needed data. Out-commuting by residents of counties is reported in the 1960 Population Census under the category of workers working outside county of residence. There is, however, no published data by counties to describe in-commuting which might be described as workers residing outside of county of work. Obviously no net figure on commuting can be obtained unless an estimate of in-commuting is made for the area being analyzed. The estimate prepared by the writer involved a multiplication of a standard percentage, 8.6 percent, times the 1960 nonagricultural employment residing in and working in the county. The 8.6 percent figure was derived by an iterative procedure for which the goal was to arrive at a net out-commuting number for the state of Iowa of 10,000 to 12,000. A second loosely constructed test involved the drawing of concentric rings of counties around major Iowa cities to determine what percentage multiplier would, in addition to meeting the above goal, yield the closest to a set of balanced labor market situations for the major cities.

Admittedly, both these tests are somewhat loose in conception and in procedure. There is no published data source which would show that Iowa's net out-commuting falls within the 10,000 to 12,000 range for 1960. There is only the fairly certain qualitative knowledge that the heavy out-commuting at Davenport and Council Bluffs outweighs the in-commuting movements for those two cities plus any net in-commuting that undoubtedly occurs at Sioux City and Dubuque. In addition, a net out-commuting estimate of 12,000 for Iowa when compared to the total Iowa employment of 1,019,002 for 1960 is in effect an estimate that the approximate level is close to zero.

The test of labor market balancing by the use of concentric rings of counties is, of course, handicapped by the fact that county boundaries do not match the true functional economic area boundaries around these cities, and so a great deal of judgment is involved in deciding when an approximate balance is reached.

Figure 5 is the Iowa map with reported numbers of workers working outside county of residence in 1960 by counties (45, pp. 238-245). Figure 6 gives the estimate of the number of workers residing outside county of work in 1960 by counties. By subtracting for each county the number in Figure 6 from the number for that county in Figure 5, the net commuting outflow is obtained for that county. Figure 7 shows the estimate of Commuters Net Outflow by counties for 1960.

The county numbers for Commuters Net Outflow are additive across counties if area commuting flows are wanted for multi-county areas. Figure 7 is, therefore, highly convenient for estimating multi-county area commuting movements for a variety of area sizes from single county to the state as a whole. However, it is likely to be more nearly accurate for multi-county situations. For some single counties the data is distorted by the location of a town on the county line in which the residents may live largely on one side of the county line whereas the main street and other business locations are largely on the other side of the line. Technically, commuting to work outside the county of residence takes place, but the differential effects on the economy from the separation of place of work and place of residence are not likely to occur to any noticeable degree when the distance of commuting is at most just a few city blocks. In multi-county situations the few single county distortions of the type just mentioned are swamped by the volume of data from other counties.

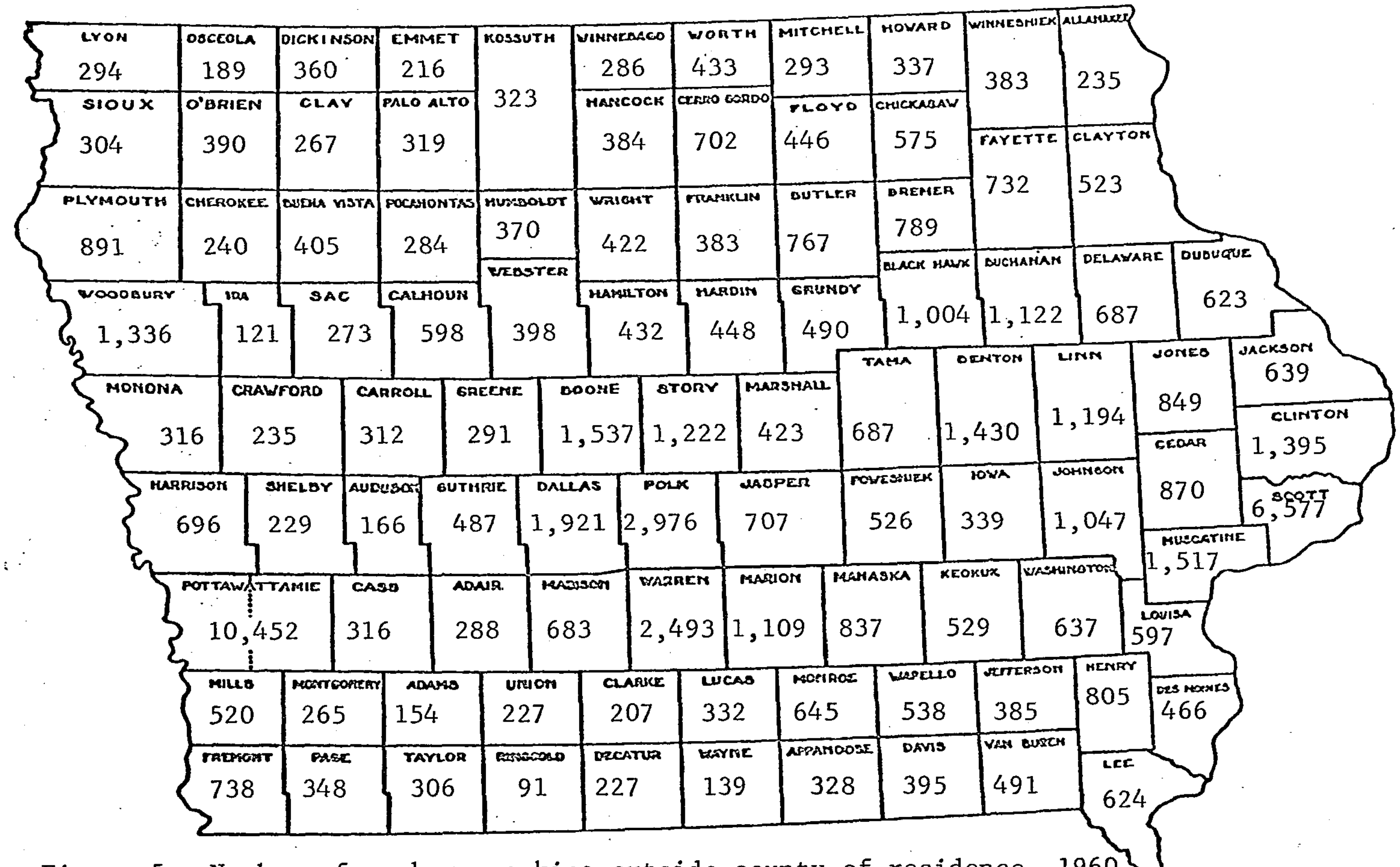

Figure 5. Number of workers working outside county of residence, 1960

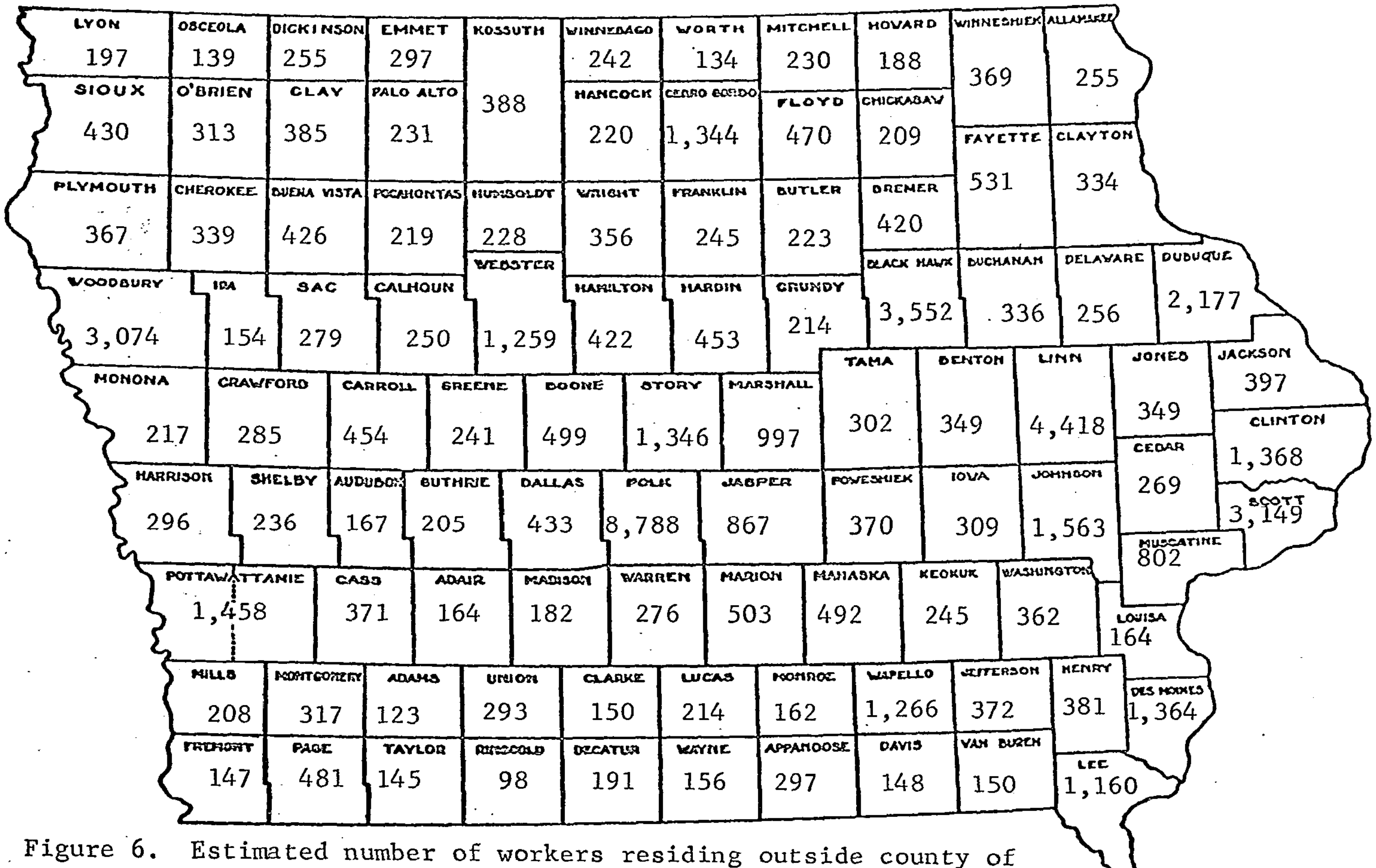

Figure 6. Estimated number of workers residing outside county of work, 1960

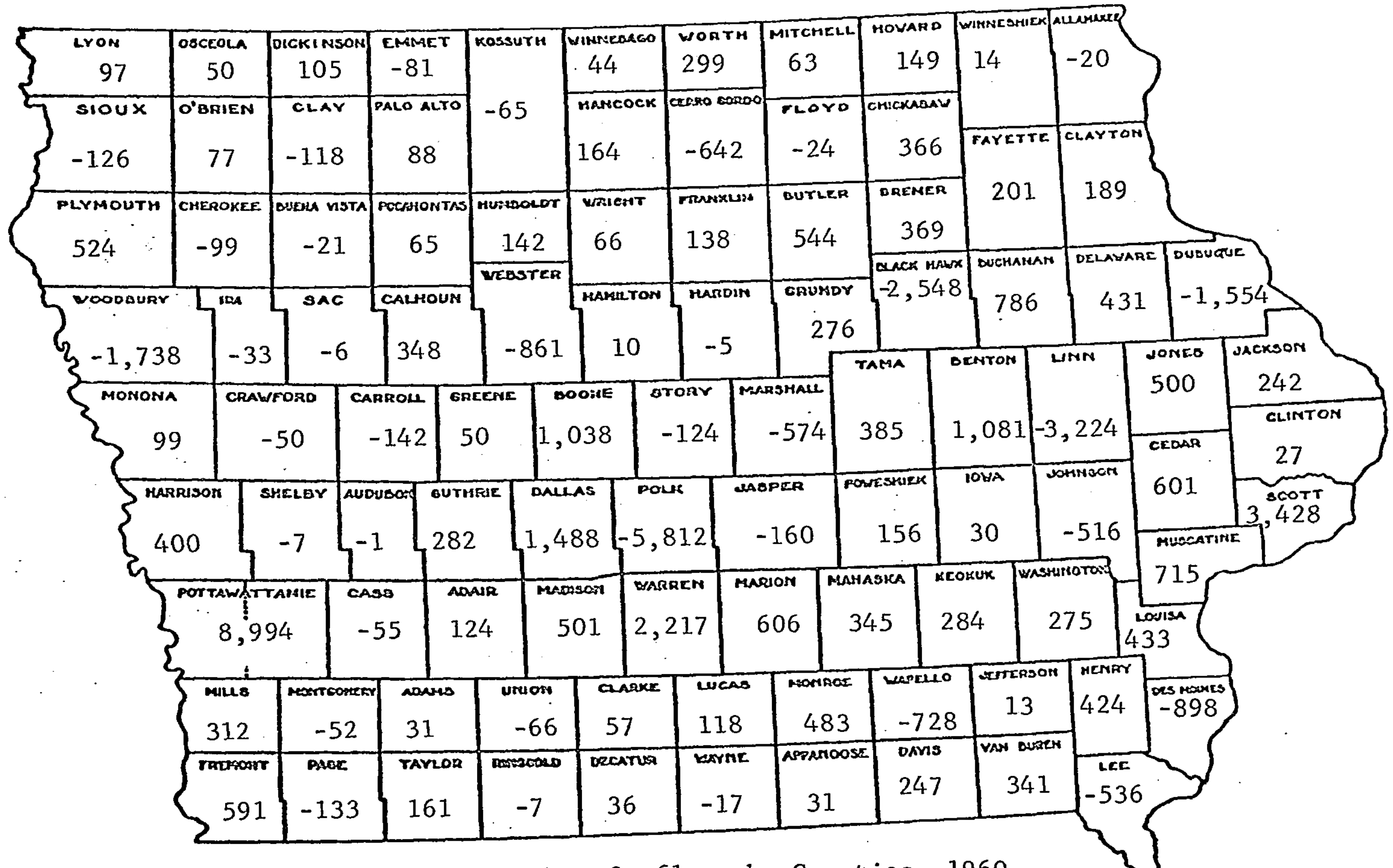

Figure 7. Estimate of Commuters Net Outflow, by Counties, 1960

Figure 7 may require some explanation. A positive number for a county indicates that the out-commuting to work in other counties exceeds the in-commuting to work in the county by the number shown. For example, Boone County had, by this estimating procedure, 1,038 of its inhabitants traveling outside of Boone County to work in excess of the number of inhabitants of other counties which traveled into Boone County to work in 1960. A quick inspection of Table 7 will show that counties located adjacent to large population counties tend to have relatively large positive net commuting numbers.

A negative number in the county block indicates the number of employees living outside the county who commuted into the county to work, in excess of the number who were commuting out of the county to work elsewhere. The counties containing the cities of Des Moines, Waterloo, Cedar Rapids, Sioux City, Dubuque, Mason City, Fort Dodge, Ottumwa, Burlington and Keokuk all show relatively large net in-commuting numbers. Davenport and Council Bluffs fail to show such in-commuting, but this can be explained by the proximity of these cities to even larger employment centers across the state boundaries.

Where Commuters Net Outflow employment numbers are given in the analysis of state administrative areas at a later point in this study, the commuting numbers were computed by adding together the net commuting numbers of the counties of the areas as these numbers are reported in Figure 7. Some other areas, designated as functional economic areas, are also analyzed, and for these it is assumed that the net commuting equals zero. All of these functional economic areas except the one designated as the Des Moines area involve counties outside Iowa in combination with some counties inside Iowa. Net commuting estimates were not made for counties outside the boundaries of Iowa and, therefore, the assumption of no net commuting for the area had to be used for areas involving non-Iowa counties. Normally where the area boundaries that were used approximate the natural boundaries of a functional economic area it should make little difference in the approximation of export employment whether or not commuting is introduced as a sector since net commuting will be only a very small part of total employment in these cases. Many of the state administrative areas which are analyzed also approximate functional economic areas. However, some of them may not approximate such areas very closely and so the commuting employment which had been estimated was used in all area analysis where the state administrative area designation was used.

When commuting employment is introduced as either a positive or negative number in an area, it is necessary to adjust the employment figures of at least some of the industries of employment in order to avoid either double counting or under counting some employees. Where net out-commuting occurs it must be the case that some of the census reported employment in industries includes employees who live in the area but work outside the area. These latter employees are to be counted in the net commuting and so they must be deducted from the appropriate industries where they have been reported. If net in-commuting is the case, it must be true that more jobs exist in some of the industries within the area than were reported by the Population Census within those industries. Since the net in-commuting effect is reported as a negative number, a comparable number of employees must be added to some of the named industries of employment in order to keep total area employment over all industries plus commuting equal to the census reported total of area residing employees. After the proper commuting adjustments have been made, each industry of employment will have as its number of employees the number of jobs existing within that industry in the area. The artificial Commuters Net Outflow industry will show the extent of either net in-commuting or net out-commuting for the area.

The estimation of commuting numbers in total rests partly on secondary data available for counties and partly on pure assumptions regarding in-commuting patterns in relation to total employment of nonagricultural sectors of the counties. The allocation of commuting numbers to industries of employment is an even more complicated problem because of the complete unavailability of data regarding industry of employment of commuters by the county level of disaggregation of areas. For the Midcrest counties it was estimated that 15 percent of the net out-commuters were employed in Construction and Related, 30 percent in Manufacturing and Related, 15 percent in Transport and Related, 10 percent in Wholesale-Retail Trade, and 30 percent in Services and Related. This set of percentages constitutes a very crude approximation, but the decision was made to use it in this form in the analysis of the Midcrest data because at least a minimum of empirical content was involved in determining these percentages.

For the division into industries of employment of the net commuting total of other areas for which export employment is to be estimated, three potential choices were available. One was to use the set of percentages which were used for the Midcrest area. This technique did not seem particularly desirable because the number of net commuters in relation to total employment in Midcrest was quite small, the possibilities for error in the informal survey technique used were rather large and there was little reason to hypothesize that the net commuting pattern of a small, quite rural area lying adjacent to a large employment, large urban center area would be at all typical of the commuting patterns by industries of a sample of variously sized areas. A second possible technique was to allow for an informal estimation procedure for each area analyzed in which the investigator would use the best information available. Such a procedure would introduce a definite possibility of personal bias into the estimations and would make it impossible for two investigators working independently to arrive at the same export estimates except by sheer accident. The ease of reproducibility of results would be lost. A third possible technique was the development of a standard set of percentages which might represent a good average of the true sets for use when areas of many different sizes and characteristics were to be estimated. Preferably the standard set of percentages would be derived from the same sort of data that was used to furnish the overall employment totals.

A special report of the 1960 Population Census entitled "Journey to Work" (48) gives commuting information by industries for selected standard metropolitan statistical areas (SMSA's) of the United States. For purposes of this study, it was desirable to find such data for an SMSA which was coincidental with a single county so that commuting across county boundaries would be measured by the data and net commuting estimates by industries could be derived. The SMSA selected should also preferably be a part of the general multi-state area from which functional economic areas and state administrative areas were to be selected for use in the testing of the hypothesis and the model.

The Des Moines, Iowa, SMSA met the requirements listed above, and the data from this SMSA (48, pp. 246-249) was accordingly subjected to an analysis designed to generate commuting patterns by industry from which a set of percentages could be derived which would allocate net commuting flows to industry of employment.

Table 15 presents the journey to work data for the Des Moines, Iowa, SMSA. The column titled "Live inside, work outside" gives the total of employees residing in Polk County

Table 15. In-commuting, out-commuting, net outflow and industry net outflow to total net outflow percentage, by industry, for Des Moines SMSA, 1960

Industry of employment	Workers in relation to SMSA			
	Live inside, work outside	Live outside, work inside	Polk County commuting net outflow	Percent, industry net outflow is of total net outflow
Agriculture and Mining	70	147	-77	1.45
Construction	452	621	-169	3.19
Manufacturing and Related	746	3,427	-2,681	50.56
Trade, Wholesale-Retail	695	1,358	-663	12.50
Transport and Related	237	773	-536	10.11
Finance and Related	242	757	-515	9.71
Services and Related	493	1,155	-662	12.48
All Industries	2,935	8,238	-5,303	100.00

by industry who are out-commuters as viewed from the Polk County viewpoint. The column titled "Live outside, work inside" gives the number of employees by industries who are in-commuters to Polk County as viewed from the Polk County viewpoint. For each industry the difference between the corresponding numbers of each column represents the net commuting outflow as viewed from the Polk County viewpoint. It may be noted that in Table 15 all industries listed show a net in-commuting pattern as indicated by the minus signs preceding each of the numbers in the "Polk county commuting net outflow" column. The absolute value of the numbers reported as net commuters by industries or in total does not differ whether these commuters are viewed from inside Polk County or from counties outside Polk County. Only the sign of the number is changed depending on whether the commuters are viewed as in-commuters or out-commuters from the standpoint of the county concerned. For this reason, therefore, we can determine what percent each industry's net commuting number is of the total net commuting number and say that this resulting percentage and the set of all such percentages can represent the industry shares of a commuting flow irrespective of the direction of the commuting flow. The set of percentages derived from the Des Moines, Iowa, SMSA is given in the column titled "Percent industry net outflow is of total net outflow."

The assumption that the Polk County set of percentages can be applied to commuting flows of other areas of Iowa or on the Iowa borders is not easy to defend. In later computations relating to other areas the Polk County set of percentages was rounded to the nearest 5 percent for each industry. Accordingly, the percentage for Construction and Related is 5 percent, for Manufacturing and Related it is 50 percent, for Transport and Related it is 10 percent, for Trade it is 15 percent, for Finance and Related it is 10 percent and for Services and Related it is 10 percent. This latter rounded set of percentages becomes the standard set of allocators for allocating commuting flows to named industries of employment. The main rationale for using this set is that it is derived from a recognized source of secondary data, it does represent the conditions found in the large functional economic area which is located at about the center of the geographical area of all the areas tested and the Des Moines, Iowa SMSA and surrounding territory has a fairly balanced or "average" employment structure in comparison with all the other areas to which the commuting allocator set will be applied. It may be noted also that the net commuting outflow of minus 5,303 is only 500 less than the estimated net commuting outflow for Polk County as shown on Figure 7 which was derived by a different technique. In fact, if the data shown as "Place of work not reported" could have been allocated to commuting and non-commuting categories for Polk County and counties surrounding Polk, it is likely that the agreement of total commuting flows as listed in Figure 7 and Table 15 would have been even closer.

The issue of commuting causes some troublesome complications throughout this study. It might have been desirable to have eliminated commuting from consideration, and it seems certain that the model should be expected to perform more realistically for areas where commuting is a small part of the total employment picture as compared to areas where commuting is a large part of total employment. On the other hand, the model should certainly be made workable for areas where commuting is likely to be a large part of employment, since demands for export approximation are likely to arise from many areas of this latter type.

IV. FINDINGS

A. General Outline

Some of the information on gathering and analysis of data of the Midcrest area which was presented in Chapter III might conceivably have been placed in the present chapter. However, it seemed more appropriate to reserve the "findings" section of this study for a reporting of the results of the use of the Midcrest technology matrix on the employment data of other areas. The reported findings consist of approximated export vectors from areas other than Midcrest. The characteristics of these vectors with relation to the realism of the estimates are also reported as a part of the findings, and finally comparisons are made between these estimates and some empirically derived export magnitudes for three areas of Iowa.

Two of these empirical studies involved only the manufacturing sectors of the Fort Dodge and Mason City areas of Iowa. A third study involved all sectors of the Sioux City urbanized area of 1958.

B. The Model Applied to Areas

1. Selection of appropriate areas

It seemed that the appropriate areas for use in testing of the adjusted Midcrest matrix would be those areas that were located geographically close to Midcrest. Of particular interest to the staff of Iowa State University and its University Extension Service and officials of the state of Iowa would be the use of the model on all relevant Iowa areas. A problem connected with the use of exclusively Iowa areas is the existence of some functional economic areas on the Iowa borders which areas lie partially in surrounding states.

Fortunately, a set of functional economic areas covering the entire United States has been recently delineated by Brian Berry (35) and his associates under a contract with the United States Census Bureau under the direction of the Social Science Research Council areas committee of which Karl A. Fox is chairman. The areas delineated through this study procedure were based very largely on unpublished commuting data from the 1960 Population Census. Presumably, therefore, these areas come as close to a representation of balanced labor market areas as is possible using data available and by drawing the boundaries along county boundary lines.

Figure 8 shows the Iowa and vicinity portion of the United States map on which is drawn the boundaries of certain of the identified functional economic areas. The heavily outlined and labeled areas in this figure are the ones on which the first round of operation of the model is performed. For these areas, the assumption is made that net commuting is zero. The areas to be treated in this round are located on the Iowa borders with the exception of the Des Moines area. The Berry project identified other functional economic areas lying entirely within Iowa, but most of these are similar in outline to the proposed state administrative areas which are analyzed in the

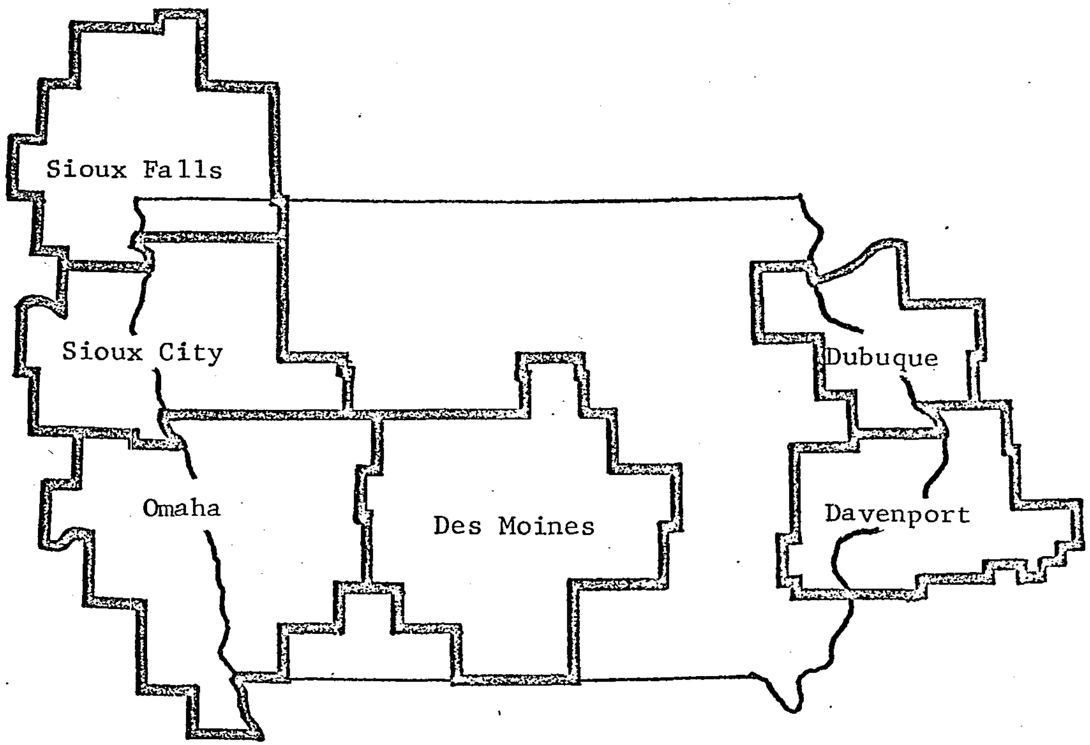

Figure 8. A selected set of "Berry" functional economic areas

second round of testing and much duplication would have occurred by treating them also in this first round. The Des Moines area from the Berry study is considerably larger than the Des Moines state administrative area and so a lesser degree of duplication occurred by analyzing this general area in both rounds of testing.

2. Results with functional economic areas

Population Census data (41, 42, 43, 45, 46, 47) and the adjustment procedures for the data for this first round of testing are found in Tables 16 through 34.

Tables 16 through 21 present the process of the allocation of Industry Not Reported employment to the named industries. The end result is the single adjusted employment breakdown. For the functional economic areas of this first round of treatment this is also the double adjusted employment since commuting has been assumed to be zero. The column titled "Allocation factors" in Table 16 actually gives the proportions by which single adjusted employment is divided into specific industries of employment. If the decimal place is moved two places to the right for the allocation factors the result will be a set of allocation percentages and also a set of division of employment percentages. In Table 16, for example, Agriculture and Related can be shown to be 15.19 percent of the total employment of the Omaha functional economic area.

Tables 22 through 27 present the results of the operation of the model itself. The left-hand column of numbers is

Table 16. Omaha functional economic area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	40,916	0.15191	1,345	42,261
Construction and Related	18,333	0.06806	603	18,936
Manufacturing and Related	45,844	0.17021	1,508	47,352
Trade, Wholesale-Retail	54,748	0.20326	1,800	56,548
Transportation and Related	28,342	0.10523	932	29,274
Finance and Related	15,158	0.05628	499	15,657
Services and Related	66,004	0.24505	2,171	68,175
Industry Not Reported	8,858	-1.00000	-8,858	0
All Industries	278,203	0.00000	0	278,203

Table 17. Des Moines functional economic area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	38,369	0.156862	1,000	39,369
Construction and Related	15,163	0.061990	395	15,558
Manufacturing and Related	42,717	0.174637	1,113	43,830
Trade, Wholesale-Retail	49,969	0.204285	1,302	51,271
Transportation and Related	16,960	0.069337	442	17,402
Finance and Related	14,447	0.059063	377	14,824
Services and Related	66,979	0.273826	1,746	68,725
Industry Not Reported	6,375	-1.000000	-6,375	0
All Industries	250,979	0.000000	0	250,979

Table 18. Davenport functional economic area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	25,487	0.12309	776	26,263
Construction and Related	10,344	0.04996	315	10,659
Manufacturing and Related	68,260	0.32967	2,077	70,337
Trade, Wholesale-Retail	39,153	0.18910	1,192	40,345
Transportation and Related	12,912	0.06236	393	13,305
Finance and Related	6,839	0.03303	208	7,047
Services and Related	44,060	0.21279	1,341	45,401
Industry Not Reported	6,302	-1.00000	-6,302	0
All Industries	213,357	0.00000	0	213,357

Table 19. Sioux City functional economic area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	27,098	0.26850	740	27,838
Construction and Related	5,453	0.05403	149	5,602
Manufacturing and Related	13,138	0.13017	359	13,497
Trade, Wholesale-Retail	21,804	0.21604	595	22,399
Transportation and Related	6,182	0.06125	169	6,351
Finance and Related	2,962	0.02935	81	3,043
Services and Related	24,289	0.24066	663	24,952
Industry Not Reported	2,756	-1.00000	-2,756	0
All Industries	103,682	1.00000	0	103,682

Table 20. Sioux Falls functional economic area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	27,825	0.31023	689	28,514
Construction and Related	4,674	0.5211	116	4,790
Manufacturing and Related	9,128	0.10177	226	9,354
Trade, Wholesale-Retail	18,205	0.20298	450	18,655
Transportation and Related	5,034	0.05613	125	5,159
Finance and Related	2,801	0.03123	69	2,870
Services and Related	22,024	0.24555	545	22,569
Industry Not Reported	2,220	-1.00000	-2,220	0
All Industries	91,911	0.00000	0	91,911

Table 21. Dubuque functional economic area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	18,594	0.25923	496	19,090
Construction and Related	3,909	0.05450	104	4,013
Manufacturing and Related	15,321	0.21360	409	15,730
Trade, Wholesale-Retail	12,699	0.17705	339	13,038
Transportation and Related	3,762	0.05245	101	3,863
Finance and Related	1,718	0.02395	46	1,764
Services and Related	15,724	0.21922	420	16,144
Industry Not Reported	1,915	-1.00000	-1,915	0
All Industries	73,642	0.00000	0	73,642

Table 22. Omaha functional area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	42,261	33,608	0.79525	0.25395
Construction and Related	18,936	5,328	0.28137	0.04026
Manufacturing and Related	47,352	38,616	0.81551	0.29180
Trade, Wholesale-Retail	56,548	17,340	0.30664	0.13103
Transportation and Related	29,274	17,652	0.60299	0.13338
Finance and Related	15,657	9,146	0.58415	0.06911
Services and Related	68,175	10,649	0.15620	0.08047
Commuters Net Outflow	0	0	1.00000	0.00000
All Industries	278,203	132,339	0.47569	1.00000

Table 23. Des Moines functional economic area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	39,369	31,649	0.80391	0.26352
Construction and Related	15,558	3,326	0.21378	0.02769
Manufacturing and Related	43,830	36,166	0.82514	0.30113
Trade, Wholesale-Retail	51,271	15,971	0.31150	0.13298
Transportation and Related	17,402	6,988	0.40156	0.05819
Finance and Related	14,824	8,999	0.60706	0.07493
Services and Related	68,725	17,002	0.24739	0.14156
Commuters, Net Outflow	0	0	1.00000	0.00000
All Industries	250,979	120,101	0.47853	1.00000

Table 24. Davenport functional economic area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	26,263	19,812	0.75438	0.18982
Construction and Related	10,659	651	0.06108	0.00624
Manufacturing and Related	70,337	64,041	0.91049	0.61360
Trade, Wholesale-Retail	40,345	11,502	0.28509	0.11020
Transportation and Related	13,305	4,548	0.34183	0.04358
Finance and Related	7,047	2,160	0.30651	0.02069
Services and Related	45,401	1,656	0.03647	0.01587
Commuters, Net Outflow	0	0	1.00000	0.00000
All Industries	213,357	104,370	0.48918	1.00000

Table 25. Sioux City functional economic area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	27,838	24,932	0.89610	0.49051
Construction and Related	5,602	436	0.07783	0.00858
Manufacturing and Related	13,497	11,006	0.81544	0.21653
Trade, Wholesale-Retail	22,399	7,185	0.32077	0.14136
Transportation and Related	6,351	2,293	0.36105	0.04512
Finance and Related	3,043	801	0.26323	0.01576
Services and Related	24,952	4,175	0.16732	0.08214
Commuters, Net Outflow	0	0	1.00000	0.00000
All Industries	103,682	50,828	0.49023	1.00000

Table 26. Sioux Falls functional economic area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	28,514	25,969	0.91075	0.57643
Construction and Related	4,790	136	0.02839	0.00302
Manufacturing and Related	9,354	7,295	0.77988	0.16193
Trade, Wholesale-Retail	18,655	4,937	0.26465	0.10959
Transportation and Related	5,159	1,591	0.30839	0.03532
Finance and Related	2,870	901	0.31394	0.02000
Services and Related	22,569	4,222	0.18707	0.09371
Commuters Net Outflow	0	0	1.00000	0.00000
All Industries	91,911	45,051	0.49016	1.00000

Table 27. Dubuque functional economic area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	19,090	17,098	0.89565	0.45946
Construction and Related	4,013	462	0.11513	0.01242
Manufacturing and Related	15,730	14,239	0.90521	0.38263
Trade, Wholesale-Retail	13,038	2,611	0.20026	0.07016
Transportation and Related	3,863	1,045	0.27052	0.02808
Finance and Related	1,764	213	0.12075	0.00573
Services and Related	16,144	1,545	0.09570	0.04152
Commuters Net Outflow	0	0	1.00000	0.00000
All Industries	73,642	37,213	0.50532	1.00000

identical to the single adjusted employment column of Table 16, but is here identified as area residing employees since this latter designation is one of two designations to be used as a basis for comparison in later analysis.

Between the first and second columns of Tables 22 through 27, a considerable amount of mathematical computation takes place in the process of solving for the numbers of the second column which is titled "Export employees". Briefly stated, the operation involves the adjustment of the Midcrest matrix of coefficients through a premultiplication by a diagonal matrix of appropriate diagonal elements which are the adjustment multipliers respectively for each of the rows of the Midcrest matrix. The adjusted matrix is then post-multiplied by the column vector of the 1960 area employees. Thus the 1960 export employment column vector is seen to be a computed estimate of exports using the hypothesis and the procedure previously outlined. The third column of Tables 22 through 27 gives for each industry the proportion which that industry's export is of the total employment of that industry in the area. The fourth column of Tables 22 through 27 gives the proportion which each industry's export employment is of the total export employment of the area. These two types of proportions or ratios allow us to say that Agriculture and Related of the Omaha functional economic area has 79 percent of its employment engaged in export activity and that this export employment is slightly over 25 percent of the total export employment of the area. The three right-hand columns of Tables 22 through 27 provide the summary of the export estimates which are calculated by the model and on which the model must stand or fall depending upon the apparent realism of these sets of estimates.

Tables 28 through 34 provide the same information as that included in Tables 22 through 27, but each industry is treated separately with areas being compared for the particular industry. The first column of each table presents export employment in absolute numbers and provides the opportunity to visualize the relative magnitude of the export volume of the industry in each area. The second column provides the opportunity to visualize the relative proportion of the industry which is export oriented for each of the areas. The industries of Agriculture and Related, Manufacturing and Related and Trade, Wholesale-Retail exhibit only minor variability in this latter characteristic. Agriculture and Manufacturing are both relatively highly oriented toward export activity in all of the areas. Trade has only a moderate export orientation, but it is between 20 percent and 32 percent of total industry activity for each of the areas.

The industries of Construction and Related, Transport and Related, Finance and Related and Services and Related each exhibit more variability in the proportion of industry activity that is export oriented. For the six areas, Construction varies from 2 percent to 28 percent; Transport varies from 27 percent to 60 percent; Finance varies from 12 percent to 61 percent and

Table 28. Agriculture and Related 1960 employment by selected functional economic areas and by export employment number and selected export ratios

Functional economic area	Export employment	Ratio of Agriculture export to Agriculture total	Ratio of Agriculture export to all industries export
Omaha	33,608	0.79525	0.25395
Des Moines	31,649	0.80391	0.26352
Davenport	19,812	0.75438	0.18982
Sioux City	24,932	0.89610	0.49051
Sioux Falls	25,969	0.91075	0.57643
Dubuque	17,098	0.89565	0.45946

Table 29. Construction and Related 1960 employment by selected functional economic areas and by export employment number and selected export ratios

Functional economic area	Export employment	Ratio of Construction export to Construction total	Ratio of Construction export to all industries export
Omaha	5,328	0.28137	0.04026
Des Moines	3,326	0.21378	0.02769
Davenport	651	0.06108	0.00624
Sioux City	436	0.07783	0.00858
Sioux Falls	136	0.02839	0.00302
Dubuque	462	0.11513	0.01242

Table 30. Manufacturing and Related 1960 employment by selected functional economic areas and by export employment number and selected export ratios

Functional economic area	Export employment	Ratio of Manufacturing export to manufacturing total	Ratio of Manufacturing export to all industries export
Omaha	38,616	0.81551	0.29180
Des Moines	36,166	0.82514	0.30113
Davenport	64,041	0.91049	0.61360
Sioux City	11,006	0.81544	0.21653
Sioux Falls	7,295	0.77988	0.16193
Dubuque	14,239	0.90521	0.38263

Table 31. Trade, Wholesale-Retail 1960 employment by selected functional economic areas and by export employment number and selected export ratios

Functional economic area	Export employment	Ratio of Trade export to Trade total	Ratio of Trade export to all industries export
Omaha	17,340	0.30664	0.13103
Des Moines	15,971	0.31150	0.13298
Davenport	11,502	0.28509	0.11020
Sioux City	7,185	0.32077	0.14136
Sioux Falls	4,937	0.26465	0.10959
Dubuque	2,611	0.20026	0.07016

Table 32. Transportation and Related 1960 employment by selected functional economic areas and by export employment number and selected export ratios

Functional economic area	Export employment	Ratio of Transportation export to Transportation total	Ratio of Transportation export to all industries export
Omaha	17,652	0.60299	0.13338
Des Moines	6,988	0.40156	0.05819
Davenport	4,548	0.34183	0.04358
Sioux City	2,293	0.36105	0.04512
Sioux Falls	1,591	0.30839	0.03532
Dubuque	1,045	0.27052	0.02808

Table 33. Finance and Related 1960 employment by selected functional economic areas and by export employment number and selected export ratios

Functional economic area	Export employment	Ratio of Finance export to Finance total	Ratio of Finance export to all industries export
Omaha	9,146	0.58415	0.06911
Des Moines	8,999	0.60706	0.07493
Davenport	2,160	0.30651	0.02069
Sioux City	801	0.26323	0.01576
Sioux Falls	901	0.31394	0.02000
Dubuque	213	0.12075	0.00573

Table 34. Services and Related 1960 employment by selected functional economic areas and by export employment number and selected export ratios

Functional economic area	Export employment	Ratio of Services export to Services total	Ratio of Services export to all industries export
Omaha	10,649	0.15620	0.08047
Des Moines	17,002	0.24739	0.14156
Davenport	1,656	0.03647	0.01587
Sioux City	4,175	0.16732	0.08214
Sioux Falls	4,222	0.18707	0.09371
Dubuque	1,545	0.09570	0.04152

Services varies from 3 percent to 25 percent. The range of values found for the ratio of industry export to industry total for the four industries indicates that the use of any standard percentage value for any of these industries would not provide a good approximation of the export activity of that industry for all areas.

On the other hand, judging on the basis of the computations for the six functional economic areas, it might be assumed that the use of standard export allocation percentages for the industries of Agriculture, Manufacturing and Trade would provide reasonable approximations of the true degree of export orientation of these industries in many areas.

Up to this point the model has been tested in the sense that it has been used on the 1960 Population Census data on employment by industry for six selected functional economic areas, and it has produced potentially realistic results. The results are realistic to the extent that no negative export numbers were generated, the overall export-residentiary ratios for all the areas remain comparable at approximately 0.5 and different industries approached the zero level of export activity in the several areas so that it cannot be said that the matrix is designed to keep all industries safely above the negative export level.

3. <u>Results with Iowa administrative areas</u>

A second round of testing was performed by using the export estimation model on the census data (45) of 16 areas which together exhaust the geographic area of Iowa. These areas have been proposed as a set of administrative areas for planning and, in some cases, administering activities of the state government and its departments and agencies (22).

Many of the areas approximate quite closely the functional economic areas delineated by the Berry study. Others, particularly around the larger Iowa cities, are somewhat smaller geographically than the comparable "Berry" areas because of the restriction that no Iowa resident should be required to drive more than one hour to reach his administrative area's central city.

Along the Iowa borders the Iowa administrative areas typically are only about one-half geographically of the true functional economic area which extends into two or more states whenever the central city lies on the state boundary. The procedure for the estimation of the net commuting flow is introduced actively into the model at this point because of the division of the natural functional economic areas and the substantial commuting movements which are known to occur under these circumstances.

In the second round the analysis was also run for the state of Iowa as a whole. It is not intended that the model should be transferable without additional adjustment procedures to a geographic area of this size or an employment level of this magnitude. In addition, an area such as the state of Iowa may not operate as an economic entity to any great extent since it includes parts of two major river basins, and it lacks a dominant central city of the stature of Minneapolis or St. Louis.

Nevertheless, as a matter of curiosity, the analysis was run on the Iowa data to see what would happen when the model is transferred to an employment aggregate which is much larger than that of the usual functional economic area found in the relatively rural Midwest.

Figure 9 shows the 16 proposed state administrative areas of Iowa which were delineated after a comprehensive study procedure initiated and conducted by the Iowa State Office for Planning and Programming (22). Many other sources might have been used to furnish a suggested set of areas for Iowa. Proposed Iowa area delineations have been prepared by a number of researchers and administrators of Iowa State University and by various agencies and departments of the state government and of other major institutions. The proposed state administrative area delineation system was chosen because it presumably incorporated the considerations involved in all the other delineations that were known to exist, and it also is likely to have a greater degree of official backing from state officials. This is not to suggest that the present proposed delineation will be adopted exactly as shown in Figure 9. Changes may be made after further consideration, but Figure 9 shows the latest form of the proposal at the time of incorporation into this study. The areas are identified in this study by the names of the cities which have been proposed as administrative centers.

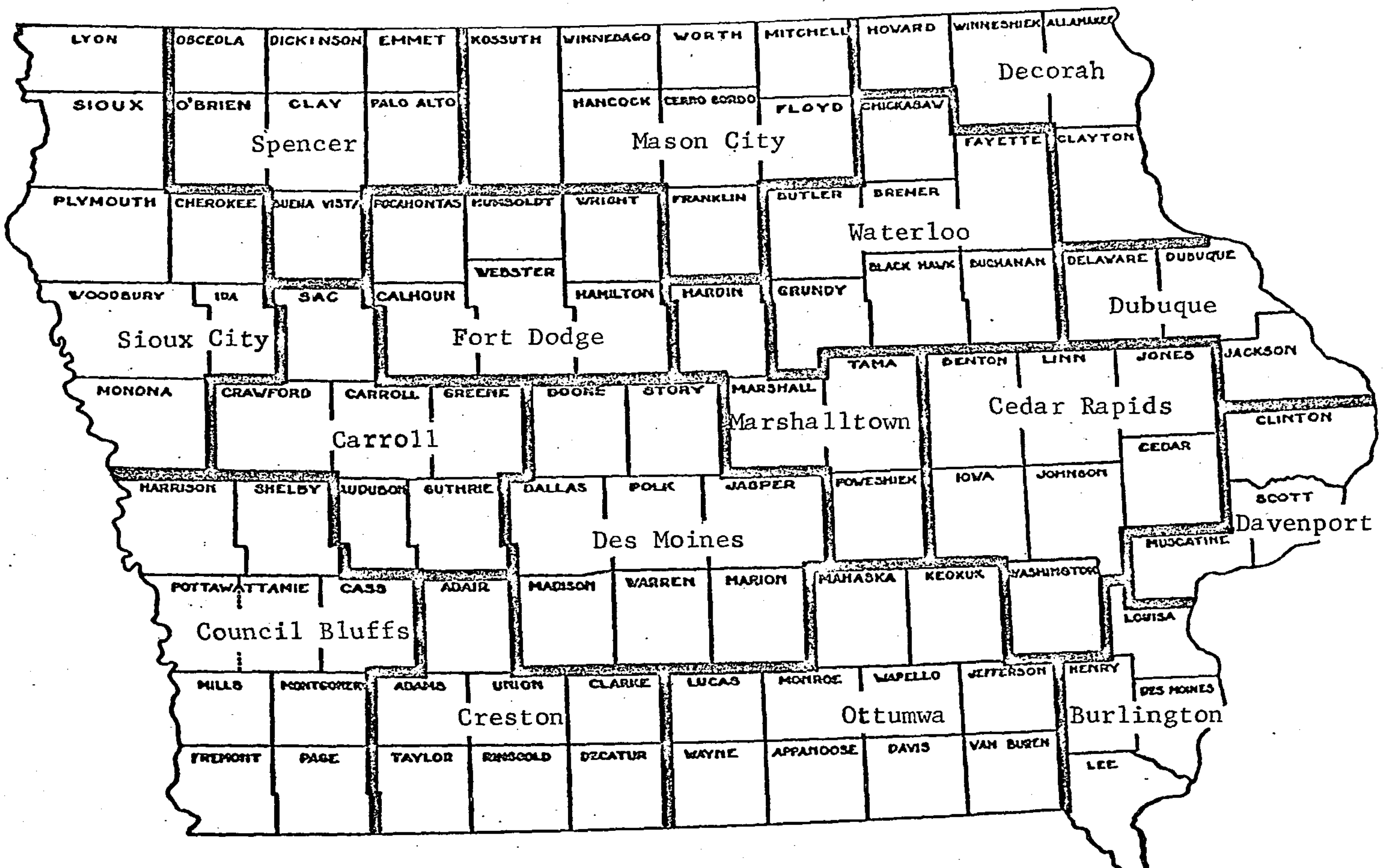

Figure 9. Proposed state administrative areas

This method of identification is preferred at the present time over the use of a numbering system since the latter is subject to change at any time. The city designations are not so likely to be changed unless major changes are made in the proposed area boundaries or in the number of administrative areas.

Tables 35 through 91 present the full sequence of the analysis of data and the use of the matrix on the state administrative areas as well as on the entire state of Iowa. It might not have been necessary to have the full sequence of all of the tables for all of the areas for some of the more routine adjustments of data. However, some readers might wish to make judgments about the realism of and the justification for various adjustments and operations particularly on one or more areas with which they are especially familiar. The inclusion of each of the analysis and results tables for each of the areas provides such readers the opportunity to make whatever comparisons they wish with any special information they may possess.

Tables 35 through 50 present the process of the allocation of Industry Not Reported employment. The tables are presented in the text in order starting with the area with the largest total employment and following consecutively according to a decreasing level of total employment. Accordingly, the table for Iowa as a whole, Table 35, is first and the Decorah area, represented by Table 50, is last. The Creston area is the smallest in 1960 total employment terms of all the proposed state administrative areas, but it is not included in this series of tables

Table 35. Iowa 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	210,503	0.21184	5,364	215,867
Construction and Related	55,361	0.05571	1,410	56,771
Manufacturing and Related	189,660	0.19087	4,833	194,493
Trade, Wholesale-Retail	198,587	0.19985	5,060	203,647
Transportation and Related	64,375	0.06478	1,640	66,015
Finance and Related	36,559	0.03679	932	37,491
Services and Related	238,637	0.24016	6,081	244,718
Industry Not Reported	25,320	-1.00000	-25,320	0
All Industries	1,019,002	0.00000	0	1,019,002

Table 36. Des Moines, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	16,883	0.09685	494	17,377
Construction and Related	11,049	0.06339	323	11,372
Manufacturing and Related	34,034	0.19524	996	35,030
Trade, Wholesale-Retail	35,910	0.20600	1,051	36,961
Transportation and Related	12,635	0.07248	370	13,005
Finance and Related	12,564	0.07207	368	12,932
Services and Related	51,244	0.29397	1,449	52,743
Industry Not Reported	5,101	-1.00000	-5,101	0
All Industries	179,420	0.00000	0	179,420

Table 37. Cedar Rapids, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	18,036	0.16447	545	18,581
Construction and Related	5,675	0.05175	171	5,846
Manufacturing and Related	26,773	0.24414	809	27,582
Trade, Wholesale-Retail	20,418	0.18619	617	21,035
Transportation and Related	5,639	0.05142	170	5,809
Finance and Related	3,509	0.03200	106	3,615
Services and Related	29,612	0.27003	894	30,506
Industry Not Reported	3,312	-1.00000	-3,312	0
All Industries	112,974	0.00000	0	112,974

Table 38. Waterloo, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	17,682	0.20643	262	17,944
Construction and Related	4,255	0.04968	63	4,318
Manufacturing and Related	21,172	0.24717	313	21,485
Trade, Wholesale-Retail	16,177	0.18886	240	16,417
Transportation and Related	5,176	0.06043	77	5,253
Finance and Related	2,445	0.02854	36	2,481
Services and Related	18,749	0.21889	278	19,027
Industry Not Reported	1,269	-1.00000	-1,269	0
All Industries	86,925	0.00000	0	86,925

Table 39. Davenport, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported		Single adjusted employment
		Allocation factors	Allocations	
Agriculture and Related	7,098	0.09402	273	7,371
Construction and Related	3,750	0.04967	144	3,894
Manufacturing and Related	24,978	0.33084	960	25,938
Trade, Wholesale-Retail	15,470	0.20490	595	16,065
Transportation and Related	4,492	0.05950	173	4,665
Finance and Related	2,808	0.03719	108	2,916
Services and Related	16,903	0.22388	650	17,553
Industry Not Reported	2,903	-1.00000	-2,903	0
All Industries	78,402	0.00000	0	78,402

Table 40. Sioux City, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	17,400	0.23467	538	17,938
Construction and Related	4,148	0.05594	128	4,276
Manufacturing and Related	10,692	0.14420	331	11,023
Trade, Wholesale-Retail	16,777	0.22627	519	17,296
Transportation and Related	4,788	0.06457	148	4,936
Finance and Related	2,350	0.03169	73	2,423
Services and Related	17,993	0.24266	556	18,549
Industry Not Reported	2,293	-1.00000	-2,293	0
All Industries	76,441	0.00000	0	76,441

Table 41. Council Bluffs, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	16,508	0.23652	267	16,775
Construction and Related	4,325	0.06197	70	4,395
Manufacturing and Related	8,218	0.11774	133	8,351
Trade, Wholesale-Retail	14,746	0.21127	238	14,984
Transportation and Related	7,737	0.11085	125	7,862
Finance and Related	2,685	0.03847	43	2,728
Services and Related	15,577	0.22318	252	15,829
Industry Not Reported	1,128	-1.00000	-1,128	0
All Industries	70,924	0.00000	0	70,924

Table 42. Ottumwa, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	15,011	0.25542	399	15,410
Construction and Related	3,591	0.06110	95	3,686
Manufacturing and Related	10,735	0.18266	285	11,020
Trade, Wholesale-Retail	11,173	0.19011	297	11,470
Transportation and Related	4,016	0.06833	107	4,123
Finance and Related	1,437	0.02445	38	1,475
Services and Related	12,808	0.21793	340	13,148
Industry Not Reported	1,561	-1.00000	-1,561	0
All Industries	60,332	0.00000	0	60,332

Table 43. Mason City, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	18,165	0.31031	289	18,454
Construction and Related	3,361	0.05741	54	3,415
Manufacturing and Related	7,991	0.13651	127	8,118
Trade, Wholesale-Retail	11,837	0.20221	189	12,026
Transportation and Related	3,152	0.05384	50	3,202
Finance and Related	1,612	0.02754	26	1,638
Services and Related	12,421	0.21218	198	12,619
Industry Not Reported	933	-1.00000	-933	0
All Industries	59,472	0.00000	0	59,472

Table 44. Fort Dodge, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	12,308	0.26953	252	12,560
Construction and Related	2,371	0.05192	49	2,420
Manufacturing and Related	7,418	0.16245	152	7,570
Trade, Wholesale-Retail	9,480	0.20760	194	9,674
Transportation and Related	2,809	0.06152	58	2,867
Finance and Related	1,285	0.02814	26	1,311
Services and Related	9,993	0.21884	205	10,198
Industry Not Reported	936	-1.00000	-936	0
All Industries	46,600	0.00000	0	46,600

Table 45. Burlington, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	5,666	0.13437	222	5,888
Construction and Related	2,102	0.04985	82	2,184
Manufacturing and Related	11,461	0.27181	449	11,910
Trade, Wholesale-Retail	8,213	0.19478	322	8,535
Transportation and Related	3,259	0.07729	128	3,387
Finance and Related	1,014	0.02405	40	1,054
Services and Related	10,451	0.24785	409	10,860
Industry Not Reported	1,652	-1.00000	-1,652	0
All Industries	43,818	0.00000	0	43,818

Table 46. Dubuque, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	8,207	0.19677	260	8,467
Construction and Related	1,973	0.04731	62	2,035
Manufacturing and Related	10,880	0.26086	344	11,224
Trade, Wholesale-Retail	7,697	0.18454	244	7,941
Transportation and Related	2,170	0.05203	69	2,239
Finance and Related	1,054	0.02527	33	1,087
Services and Related	9,727	0.23322	308	10,035
Industry Not Reported	1,320	-1.00000	-1,320	0
All Industries	43,028	0.00000	0	43,028

Table 47. Spencer, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	12,538	0.33320	277	12,815
Construction and Related	2,031	0.05397	45	2,076
Manufacturing and Related	3,750	0.09966	83	3,833
Trade, Wholesale-Retail	8,028	0.21335	177	8,205
Transportation and Related	2,077	0.05520	46	2,123
Finance and Related	1,047	0.02782	23	1,070
Services and Related	8,158	0.21680	180	8,338
Industry Not Reported	831	-1.00000	-831	0
All Industries	38,460	0.00000	0	38,460

Table 48. Marshalltown, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	10,062	0.27721	142	10,204
Construction and Related	1,938	0.05339	27	1,965
Manufacturing and Related	5,856	0.16133	83	5,939
Trade, Wholesale-Retail	7,107	0.19580	101	7,208
Transportation and Related	2,370	0.06529	34	2,404
Finance and Related	1,015	0.02796	14	1,029
Services and Related	7,950	0.21902	113	8,063
Industry Not Reported	514	-1.00000	-514	0
All Industries	36,812	0.00000	0	36,812

Table 49. Carroll, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	13,240	0.39853	288	13,528
Construction and Related	1,885	0.05674	41	1,926
Manufacturing and Related	2,452	0.07381	53	2,505
Trade, Wholesale-Retail	6,571	0.19779	143	6,714
Transportation and Related	1,564	0.04708	34	1,598
Finance and Related	724	0.02179	16	740
Services and Related	6,786	0.20426	148	6,934
Industry Not Reported	723	-1.00000	-723	0
All Industries	33,945	0.00000	0	33,945

Table 50. Decorah, Iowa administrative area 1960 employment by industry of employment and by categories leading to allocation of Industry Not Reported employment to reported industries

Industry of employment	1960 Census reported employment	Industry Not Reported: Allocation factors	Industry Not Reported: Allocations	Single adjusted employment
Agriculture and Related	11,824	0.45137	172	11,996
Construction and Related	1,579	0.06027	23	1,602
Manufacturing and Related	1,993	0.07608	29	2,022
Trade, Wholesale-Retail	4,360	0.16644	64	4,424
Transportation and Related	1,162	0.04436	17	1,179
Finance and Related	488	0.01863	7	495
Services and Related	4,790	0.18285	70	4,860
Industry Not Reported	382	-1.00000	-382	0
All Industries	26,578	0.00000	0	26,578

because it is identical to the Midcrest area for which the data adjustment results have previously been described.

The first column of each of Tables 35 through 50 shows the area employment by industry as reported by the 1960 Population Census and includes a number of employees for which the industry of employment was not reported. The second column shows the allocation factors to be used in allocating the employment of Industry Not Reported to reported industries. In addition, the allocation factor opposite each of the named industries of employment is the proportion which that industry bears to the sum of employment of all reported industries of the area. Since the allocation of Industry Not Reported employment is according to these proportions, the final adjusted employment numbers by industry will also possess this same set of proportions with relation to the total area employment.

The third column of the tables gives the allocations in numerical terms, and the fourth column gives the final result after the allocation of the Industry Not Reported employment. The fourth column is designated as the single adjusted employment by named industries of employment.

An inspection of each of Tables 35 through 50 indicates that Industry Not Reported employment varies among the areas from 1 percent to 3 percent of the total area employment and is about 2.5 percent of the total employment of Iowa as a whole. Since Industry Not Reported is such a relatively small part of total employment it is felt that the particular method of allocation that is used should not cause any appreciable distortion of the true employment status by industry for any area.

Tables 51 through 66 present the method of adjustment and results of the adjustment for commuting movements across area boundaries. In the first column of these tables the single adjusted employment by industry is reproduced from the previous set of tables. The second column in each table presents the standard set of commuter adjustment factors, the derivation of which was described previously in the text. The actual adjustments for commuting by industry are presented in the third column, and the fourth column gives the double adjusted employment which results from the adjustment procedure.

Tables 51 through 66 each include two different employment totals. One of these totals carries the row label of "Total area positions" which is defined to mean the number of jobs located in the area irrespective of the residence locations of the job holders. The second total carries the row label of "Total area employees" which is defined to mean the number of workers residing in the area irrespective of the locations of their jobs. The two different totals come into being through the introduction of the commuting activity into the adjusted set of data.

Through observation of several of this series of tables it may be noted that when net in-commuting is shown to occur the total area positions exceed the total area employees. Net in-commuting is indicated by a negative number in both the

Table 51. Iowa 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters, Net Outflow estimate of 11,708 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	215,867	0.00	0	215,867
Construction and Related	56,771	-0.05	-585	56,186
Manufacturing and Related	194,493	-0.50	-5,854	188,639
Trade, Wholesale-Retail	203,647	-0.15	-1,756	201,891
Transportation and Related	66,015	-0.10	-1,171	64,844
Finance and Related	37,491	-0.10	-1,171	36,320
Services and Related	244,718	-0.10	-1,171	243,547
Total area positions	1,019,002	-1.00	-11,708	1,007,294
Commuters Net Outflow	0	1.00	11,708	11,708
Total area employees	1,019,002	0.00	0	1,019,002

Table 52. Des Moines, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of -246 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	17,377	0.00	0	17,377
Construction and Related	11,372	-0.05	12	11,384
Manufacturing and Related	35,030	-0.50	123	35,153
Trade, Wholesale-Retail	36,961	-0.15	36	36,997
Transportation and Related	13,005	-0.10	25	13,030
Finance and Related	12,932	-0.10	25	12,957
Services and Related	52,743	-0.10	25	52,768
Total area positions	179,420	-1.00	246	179,666
Commuters Net Outflow	0	1.00	-246	-246
Total area employees	179,420	0.00	0	179,420

Table 53. Cedar Rapids, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of -1,253 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	18,581	0.00	0	18,581
Construction and Related	5,846	-0.05	63	5,909
Manufacturing and Related	27,582	-0.50	627	28,209
Trade, Wholesale-Retail	21,035	-0.15	188	21,223
Transportation and Related	5,809	-0.10	125	5,934
Finance and Related	3,615	-0.10	125	3,740
Services and Related	30,506	-0.10	125	30,631
Total area positions	112,974	-1.00	1,253	114,227
Commuters Net Outflow	0	1.00	-1,253	-1,253
Total area employees	112,974	0.00	0	112,974

Table 54. Waterloo, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of -6 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	17,944	0.00	0	17,944
Construction and Related	4,318	-0.05	0	4,318
Manufacturing and Related	21,485	-0.50	3	21,488
Trade, Wholesale-Retail	16,417	-0.15	1	16,418
Transportation and Related	5,253	-0.10	1	5,254
Finance and Related	2,481	-0.10	0	2,481
Services and Related	19,027	-0.10	1	19,028
Total area positions	86,925	-1.00	6	86,931
Commuters Net Outflow	0	1.00	-6	-6
Total area employees	86,925	0.00	0	86,925

Table 55. Davenport, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of 4,170 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	7,371	0.00	0	7,371
Construction and Related	3,894	-0.05	-208	3,686
Manufacturing and Related	25,938	-0.50	-2,085	23,853
Trade, Wholesale-Retail	16,065	-0.15	-626	15,439
Transportation and Related	4,665	-0.10	-417	4,248
Finance and Related	2,916	-0.10	-417	2,499
Services and Related	17,553	-0.10	-417	17,136
Total area positions	78,402	-1.00	-4,170	74,232
Commuters Net Outflow	0	1.00	4,170	4,170
Total area employees	78,402	0.00	0	78,402

Table 56. Sioux City, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of -1,276 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	17,938	0.00	0	17,938
Construction and Related	4,276	-0.05	63	4,339
Manufacturing and Related	11,023	-0.50	638	11,661
Trade, Wholesale-Retail	17,296	-0.15	191	17,487
Transportation and Related	4,936	-0.10	128	5,064
Finance and Related	2,423	-0.10	128	2,551
Services and Related	18,549	-0.10	128	18,677
Total area positions	76,441	-1.00	1,276	77,717
Commuters Net Outflow	0	1.00	-1,276	-1,276
Total area employees	76,441	0.00	0	76,441

Table 57. Council Bluffs, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of 10,050 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	16,775	0.00	0	16,775
Construction and Related	4,395	-0.05	-502	3,893
Manufacturing and Related	8,351	-0.50	-5,025	3,326
Trade, Wholesale-Retail	14,984	-0.15	-1,508	13,476
Transportation and Related	7,862	-0.10	-1,005	6,857
Finance and Related	2,728	-0.10	-1,005	1,723
Services and Related	15,829	-0.10	-1,005	14,824
Total area positions	70,924	-1.00	-10,050	60,874
Commuters Net Outflow	0	1.00	10,050	10,050
Total area employees	70,924	0.00	0	70,924

Table 58. Ottumwa, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of 1,117 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	15,410	0.00	0	15,410
Construction and Related	3,686	-0.05	-56	3,630
Manufacturing and Related	11,020	-0.50	-558	10,462
Trade, Wholesale-Retail	11,470	-0.15	-167	11,303
Transportation and Related	4,123	-0.10	-112	4,011
Finance and Related	1,475	-0.10	-112	1,363
Services and Related	13,148	-0.10	-112	13,036
Total area positions	60,332	-1.00	-1,117	59,215
Commuters Net Outflow	0	1.00	1,117	1,117
Total area employees	60,332	0.00	0	60,332

Table 59. Mason City, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of -23 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	18,454	0.00	0	18,454
Construction and Related	3,415	-0.05	1	3,416
Manufacturing and Related	8,118	-0.50	12	8,130
Trade, Wholesale-Retail	12,026	-0.15	4	12,030
Transportation and Related	3,202	-0.10	2	3,204
Finance and Related	1,638	-0.10	2	1,640
Services and Related	12,619	-0.10	2	12,621
Total area positions	59,472	-1.00	23	59,495
Commuters Net Outflow	0	1.00	-23	-23
Total area employees	59,472	0.00	0	59,472

Table 60. Fort Dodge, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of -230 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	12,560	0.00	0	12,560
Construction and Related	2,420	-0.05	11	2,431
Manufacturing and Related	7,570	-0.50	115	7,685
Trade, Wholesale-Retail	9,674	-0.15	35	9,709
Transportation and Related	2,867	-0.10	23	2,890
Finance and Related	1,311	-0.10	23	1,334
Services and Related	10,198	-0.10	23	10,221
Total area positions	46,600	-1.00	230	46,830
Commuters Net Outflow	0	1.00	-230	-230
Total area employees	46,600	0.00	0	46,600

Table 61. Burlington, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of -577 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	5,888	0.00	0	5,888
Construction and Related	2,184	-0.05	29	2,213
Manufacturing and Related	11,910	-0.50	288	12,198
Trade, Wholesale-Retail	8,535	-0.15	86	8,621
Transportation and Related	3,387	-0.10	58	3,445
Finance and Related	1,054	-0.10	58	1,112
Services and Related	10,860	-0.10	58	10,918
Total area positions	43,818	-1.00	577	44,395
Commuters Net Outflow	0	1.00	-577	-577
Total area employees	43,818	0.00	0	43,818

Table 62. Dubuque, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of -881 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	8,467	0.00	0	8,467
Construction and Related	2,035	-0.05	44	2,079
Manufacturing and Related	11,224	-0.50	441	11,665
Trade, Wholesale-Retail	7,941	-0.15	132	8,073
Transportation and Related	2,239	-0.10	88	2,327
Finance and Related	1,087	-0.10	88	1,175
Services and Related	10,035	-0.10	88	10,123
Total area positions	43,028	-1.00	881	43,909
Commuters Net Outflow	0	1.00	-881	-881
Total area employees	43,028	0.00	0	43,028

Table 63. Spencer, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of 100 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	12,815	0.00	0	12,815
Construction and Related	2,076	-0.05	-5	2,071
Manufacturing and Related	3,833	-0.50	-50	3,783
Trade, Wholesale-Retail	8,205	-0.15	-15	8,190
Transportation and Related	2,123	-0.10	-10	2,113
Finance and Related	1,070	-0.10	-10	1,060
Services and Related	8,338	-0.10	-10	8,328
Total area positions	38,460	-1.00	-100	38,360
Commuters Net Outflow	0	1.00	100	100
Total area employees	38,460	0.00	0	38,460

Table 64. Marshalltown, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of -38 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	10,204	0.00	0	10,204
Construction and Related	1,965	-0.05	2	1,967
Manufacturing and Related	5,939	-0.50	19	5,958
Trade, Wholesale-Retail	7,208	-0.15	5	7,213
Transportation and Related	2,404	-0.10	4	2,408
Finance and Related	1,029	-0.10	4	1,033
Services and Related	8,063	-0.10	4	8,067
Total area positions	36,812	-1.00	38	36,850
Commuters Net Outflow	0	1.00	-38	-38
Total area employees	36,812	0.00	0	36,812

Table 65. Carroll, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of 133 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	13,528	0.00	0	13,528
Construction and Related	1,926	-0.05	-7	1,919
Manufacturing and Related	2,505	-0.50	-67	2,438
Trade, Wholesale-Retail	6,714	-0.15	-20	6,694
Transportation and Related	1,598	-0.10	-13	1,585
Finance and Related	740	-0.10	-13	727
Services and Related	6,934	-0.10	-13	6,921
Total area positions	33,945	-1.00	-133	33,812
Commuters Net Outflow	0	1.00	133	133
Total area employees	33,945	0.00	0	33,945

Table 66. Decorah, Iowa administrative area 1960 employment by industry of employment and by categories leading to adjustment of single adjusted employment to reflect Commuters Net Outflow estimate of 332 workers

Industry of employment	Single adjusted employment	Commuter adjustment factors	Adjustments for commuting	Double adjusted employment
Agriculture and Related	11,996	-0.00	0	11,996
Construction and Related	1,602	-0.05	-17	1,585
Manufacturing and Related	2,022	-0.50	-166	1,856
Trade, Wholesale-Retail	4,424	-0.15	-50	4,374
Transportation and Related	1,179	-0.10	-33	1,146
Finance and Related	495	-0.10	-33	462
Services and Related	4,860	-0.10	-33	4,827
Total area positions	26,578	-1.00	-332	26,246
Commuters Net Outflow	0	1.00	332	332
Total area employees	26,578	0.00	0	26,578

third and fourth columns opposite Commuters Net Outflow. Net out-commuting is indicated by a positive number in the same specified locations of the two columns. When net out-commuting is shown to occur, the number of total area employees exceeds the number of total area positions.

The two separate totals may provide some interest in themselves, but from the standpoint of this study the greater significance lies in the recognition that both totals exist and that either type might be used as the denominator when we create the selected export ratios at another stage of analysis.

There may be some interest in observing the volume of commuting in each of the areas in relation to the total employment of the areas respectively. If we specify tentatively that a commuting movement which is less than 1 percent of area employment describes a light commuting area, we could place the Des Moines, Waterloo, Mason City, Fort Dodge, Spencer, Marshalltown and Carroll areas in this category. Of these areas the Spencer and Carroll areas have small net out-commuting movements while all the others show small net in-commuting movements.

At the other extreme we might classify areas which have net commuting movements in excess of 5 percent of total area employment as being heavy commuting areas. The Davenport and Council Bluffs areas qualify under this criterion with both having net out-commuting movements. These, of course, are border areas where it seems certain that the true functional economic areas extend into Illinois and Nebraska respectively.

Moderate commuting movements might be those which fall between 1 percent and 5 percent of total area employment. Iowa as a whole falls within this range as do the administrative areas of Cedar Rapids, Sioux City, Ottumwa, Burlington, Dubuque, Decorah and Creston. The areas designated as Ottumwa, Decorah and Creston as well as the state of Iowa exhibit net out-commuting movements. Those designated as Cedar Rapids, Sioux City, Burlington, and Dubuque exhibit net in-commuting movements.

The areas which have been classified tentatively as moderate commuting areas probably are such because the boundaries designated for them deviate somewhat from the true functional area boundaries. However, even where state boundary restrictions are not involved it may still be impossible to draw a better set of boundaries so long as county boundary lines must be followed.

The areas which have been classified as light commuting areas fulfill a necessary labor market condition for designation as functional economic areas because of the low net commuting characteristic. This condition is not, however, sufficient from the labor market standpoint. The reason is that it is possible to have a numerically balanced area in net commuting terms where heavy out-commuting from one part of an area is balanced by heavy in-commuting into another part of the area. In such a case we could be dealing with substantial parts of two functional economic areas. In the present study it is assumed that such an occurrence is prevented through the use of areas which do not have points of heavy population settlement at more than one point on or near the area boundaries. In the case of interior Iowa administrative areas there are no points of heavy population settlement on or near the area boundaries.

Tables 67 through 83 present the results of the application of the Midcrest technology matrix appropriately adjusted for area sizes to the employment data of the state of Iowa and in turn to the employment data of each of the state administrative areas. This set of tables is not identical in format. Two types of tables appear. For the areas from which net out-commuting occurs, the employment measure of "area employees" is used as a basis for comparison among industries and between export and total activities. In the tables for these areas, Commuters Net Outflow is shown as a separate industry. Export activity for these areas is measured in terms of the number of area employees involved.

For areas into which net in-commuting occurs the measure of employment which is used as a basis for comparisons is "area positions". For these areas Commuters Net Outflow is not shown as a separate industry of employment although the employment involved in this inflow has been allocated as positive additions to other industries of employment of the area. Export activity in these areas is measured in terms of the number of area positions involved.

Table 67. Iowa 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	215,867	179,297	0.83059	0.42112
Construction and Related	56,186	483	0.00860	0.00113
Manufacturing and Related	188,639	138,029	0.73171	0.32419
Trade, Wholesale-Retail	201,891	43,443	0.21518	0.10204
Transportation and Related	64,844	18,652	0.28764	0.04381
Finance and Related	36,320	9,916	0.27302	0.02329
Services and Related	243,547	24,236	0.09951	0.05692
Commuters Net Outflow	11,708	11,708	1.00000	0.02750
All Industries	1,019,002	425,764	0.41782	1.00000

Table 68. Des Moines, Iowa administrative area 1960 employment by industry of employment and by area positions, export positions and selected export ratios

Industry of employment	Area positions	Export positions	Ratio of export positions to area positions	Ratio of export positions to area export sum
Agriculture and Related	17,377	12,050	0.69345	0.13465
Construction and Related	11,384	3,141	0.27591	0.03510
Manufacturing and Related	35,153	30,268	0.86104	0.33821
Trade, Wholesale-Retail	36,997	13,216	0.35722	0.14767
Transportation and Related	13,030	5,744	0.44083	0.06418
Finance and Related	12,957	8,900	0.68689	0.09945
Services and Related	52,768	16,175	0.30653	0.18074
All Industries	179,666	89,494	0.49811	1.00000

Table 69. Cedar Rapids, Iowa administrative area 1960 employment by industry of employment and by area positions, export positions and selected export ratios

Industry of employment	Area positions	Export positions	Ratio of export positions to area positions	Ratio of export positions to area export sum
Agriculture and Related	18,581	15,386	0.82805	0.26481
Construction and Related	5,909	643	0.10882	0.01107
Manufacturing and Related	29,209	25,558	0.90602	0.43988
Trade, Wholesale-Retail	21,223	5,913	0.27861	0.10177
Transportation and Related	5,934	1,456	0.24537	0.02506
Finance and Related	3,740	1,266	0.33850	0.02179
Services and Related	30,631	7,880	0.25726	0.13562
All Industries	114,227	58,102	0.50865	1.00000

Table 70. Waterloo, Iowa administrative area 1960 employment by industry of employment and by area positions, export positions and selected export ratios

Industry of employment	Area positions	Export positions	Ratio of export positions to area positions	Ratio of export positions to area export sum
Agriculture and Related	17,944	15,551	0.86664	0.35400
Construction and Related	4,318	149	0.03451	0.00339
Manufacturing and Related	21,488	19,582	0.91130	0.44576
Trade, Wholesale-Retail	16,418	4,426	0.26958	0.10075
Transportation and Related	5,254	1,891	0.35992	0.04304
Finance and Related	2,481	626	0.25232	0.01425
Services and Related	19,028	1,705	0.08960	0.03881
All Industries	86,931	43,930	0.50534	1.00000

Table 71. Davenport, Iowa state administrative area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	7,371	5,236	0.71035	0.12646
Construction and Related	3,686	300	0.08139	0.00724
Manufacturing and Related	23,853	22,178	0.92978	0.53564
Trade, Wholesale-Retail	15,439	5,574	0.36103	0.13462
Transportation and Related	4,248	1,336	0.31450	0.03227
Finance and Related	2,499	884	0.35374	0.02135
Services and Related	17,136	1,727	0.10078	0.04171
Commuters Net Outflow	4,170	4,170	1.00000	0.10071
All Industries	78,402	41,405	0.52811	1.00000

Table 72. Sioux City, Iowa administrative area 1960 employment by industry of employment and by area positions, export positions and selected export ratios

Industry of employment	Area positions	Export positions	Ratio of export positions to area positions	Ratio of export positions to area export sum
Agriculture and Related	17,938	15,862	0.88427	0.40250
Construction and Related	4,339	656	0.15119	0.01665
Manufacturing and Related	11,661	9,930	0.85156	0.25197
Trade, Wholesale-Retail	17,487	6,482	0.37068	0.16448
Transportation and Related	5,064	2,100	0.41469	0.05328
Finance and Related	2,551	923	0.36182	0.02342
Services and Related	18,677	3,456	0.18504	0.08770
All Industries	77,717	39,409	0.50708	1.00000

Table 73. Council Bluffs, Iowa state administrative area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	16,775	14,862	0.88596	0.40043
Construction and Related	3,893	572	0.14693	0.01541
Manufacturing and Related	3,326	1,993	0.59922	0.05370
Trade, Wholesale-Retail	13,476	3,735	0.27716	0.10063
Transportation and Related	6,857	4,392	0.64051	0.11834
Finance and Related	1,723	339	0.19675	0.00913
Services and Related	14,824	1,172	0.07906	0.03158
Commuters Net Outflow	10,050	10,050	1.00000	0.27078
All Industries	70,924	37,115	0.52331	1.00000

Table 74. Ottumwa, Iowa state administrative area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	15,410	13,811	0.89624	0.44693
Construction and Related	3,630	758	0.27725	0.02453
Manufacturing and Related	10,462	9,306	0.88950	0.30114
Trade, Wholesale-Retail	11,303	2,835	0.25082	0.09174
Transportation and Related	4,011	1,758	0.43829	0.05689
Finance and Related	1,363	124	0.09098	0.00401
Services and Related	13,036	1,193	0.10353	0.03861
Commuters Net Outflow	1,117	1,117	1.00000	0.03615
All Industries	60,332	30,902	0.51220	1.00000

Table 75. Mason City, Iowa administrative area 1960 employment by industry of employment and by area positions, export positions and selected export ratios

Industry of employment	Area positions	Export positions	Ratio of export positions to area positions	Ratio of export positions to area export sum
Agriculture and Related	18,454	16,880	0.91471	0.56472
Construction and Related	3,416	477	0.13964	0.01596
Manufacturing and Related	8,130	6,948	0.85461	0.23244
Trade, Wholesale-Retail	12,030	3,312	0.27531	0.11080
Transportation and Related	3,204	958	0.29900	0.03205
Finance and Related	1,640	408	0.24878	0.01365
Services and Related	12,621	908	0.07194	0.03038
All Industries	59,495	29,891	0.50241	1.00000

Table 76. Fort Dodge, Iowa administrative area 1960 employment by industry of employment and by area positions, export positions and selected export ratios

Industry of employment	Area positions	Export positions	Ratio of export positions to area positions	Ratio of export positions to area export sum
Agriculture and Related	12,560	11,356	0.90414	0.47031
Construction and Related	2,431	214	0.08803	0.00886
Manufacturing and Related	7,685	6,811	0.88627	0.28208
Trade, Wholesale-Retail	9,709	3,121	0.32145	0.12926
Transportation and Related	2,890	1,153	0.39896	0.04775
Finance and Related	1,334	385	0.28861	0.01594
Services and Related	10,221	1,106	0.10821	0.04580
All Industries	46,830	24,146	0.51561	1.00000

Table 77. Burlington, Iowa administrative area 1960 employment by industry of employment and by area positions, export positions and selected export ratios

Industry of employment	Area positions	Export positions	Ratio of export positions to area positions	Ratio of export positions to area export sum
Agriculture and Related	5,888	4,764	0.80910	0.19936
Construction and Related	2,213	313	0.14144	0.01310
Manufacturing and Related	12,198	11,407	0.93515	0.47736
Trade, Wholesale-Retail	8,621	3,033	0.35182	0.12693
Transportation and Related	3,445	1,810	0.52540	0.07574
Finance and Related	1,112	220	0.19784	0.00921
Services and Related	10,918	2,349	0.21515	0.09830
All Industries	44,395	23,896	0.53826	1.00000

Table 78. Dubuque, Iowa administrative area 1960 employment by industry of employment and by area positions, export positions and selected export ratios

Industry of employment	Area positions	Export positions	Ratio of export positions to area positions	Ratio of export positions to area export sum
Agriculture and Related	8,467	7,365	0.86985	0.31391
Construction and Related	2,079	138	0.06638	0.00588
Manufacturing and Related	11,665	10,897	0.93416	0.46445
Trade, Wholesale-Retail	8,073	2,350	0.29109	0.10016
Transportation and Related	2,327	715	0.30726	0.03048
Finance and Related	1,175	297	0.25277	0.01266
Services and Related	10,123	1,700	0.16793	0.07246
All Industries	43,909	23,462	0.53433	1.00000

Table 79. Spencer, Iowa state administrative area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	12,815	11,841	0.92400	0.60250
Construction and Related	2,071	188	0.09078	0.00956
Manufacturing and Related	3,783	3,100	0.81946	0.15774
Trade, Wholesale-Retail	8,190	2,570	0.31380	0.13077
Transportation and Related	2,113	703	0.33270	0.03577
Finance and Related	1,060	291	0.27453	0.01481
Services and Related	8,328	860	0.10327	0.04376
Commuters Net Outflow	100	100	1.00000	0.00509
All Industries	38,460	19,653	0.51100	1.00000

Table 80. Marshalltown, Iowa administrative area 1960 employment by industry of employment and by area positions, export positions and selected export ratios

Industry of employment	Area positions	Export positions	Ratio of export positions to area positions	Ratio of export positions to area export sum
Agriculture and Related	10,204	9,276	0.90906	0.48254
Construction and Related	1,967	234	0.11896	0.01217
Manufacturing and Related	5,958	5,333	0.89510	0.27743
Trade, Wholesale-Retail	7,213	2,062	0.28587	0.10727
Transportation and Related	2,408	1,096	0.45515	0.05702
Finance and Related	1,033	298	0.28848	0.01550
Services and Related	8,067	924	0.11454	0.04807
All Industries	36,850	19,223	0.52166	1.00000

Table 81. Carroll, Iowa state administrative area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	13,528	12,679	0.93724	0.73600
Construction and Related	1,919	208	0.10839	0.01208
Manufacturing and Related	2,438	1,874	0.76866	0.10878
Trade, Wholesale-Retail	6,694	1,569	0.23439	0.09108
Transportation and Related	1,585	351	0.22145	0.02037
Finance and Related	727	55	0.07565	0.00319
Services and Related	6,921	358	0.05507	0.02078
Commuters Net Outflow	133	133	1.00000	0.00772
All Industries	33,945	17,227	0.50750	1.00000

Table 82. Decorah, Iowa state administrative area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	11,996	11,347	0.94590	0.83538
Construction and Related	1,585	231	0.14574	0.01700
Manufacturing and Related	1,856	1,471	0.79256	0.10830
Trade, Wholesale-Retail	4,374	318	0.07270	0.02341
Transportation and Related	1,146	200	0.17452	0.01472
Finance and Related	462	-52	-0.11255	-0.00381
Services and Related	4,827	-264	-0.05469	-0.01944
Commuters Net Outflow	332	332	1.00000	0.02444
All Industries	26,578	13,583	0.51106	1.00000

Table 83. Creston, Iowa state administrative area 1960 employment by industry of employment and by area employees, export employees and selected export ratios

Industry of employment	Area employees	Export employees	Ratio of export employees to area employees	Ratio of export employees to area export sum
Agriculture and Related	10,062	9,458	0.94000	0.73582
Construction and Related	1,304	71	0.05437	0.00552
Manufacturing and Related	1,179	812	0.68897	0.06319
Trade, Wholesale-Retail	4,677	978	0.20908	0.07608
Transportation and Related	1,305	424	0.32516	0.03301
Finance and Related	532	53	0.10000	0.00414
Services and Related	5,476	721	0.13167	0.05610
Commuters Net Outflow	336	336	1.00000	0.02614
All Industries	24,871	12,853	0.51682	1.00000

If for areas experiencing in-commuting, Commuters Net Outflow employment were entered as an industry with a negative employment, there would be no discrepancy between the two sets of total and export employments in a mathematical sense. However, the selected export ratios related to Commuters Net Outflow would be negative, and the sum over all other industries of the ratios of export employment to area export would be greater than unity. We would have difficulty in interpreting the meaning of the ratios and of some of the comparisons among ratios.

As the tables stand the comparisons can be made entirely among positive numbers and positive ratios. In that sense the tables are set up in the most convenient form. However, exact comparability then eludes us in the total employment and export employment magnitudes and the ratios formed from them.

The first column of each table lists the employment by industry of the area in terms of either area employees or area positions according to the commuting situation. The second column, which is entitled "Export employees" for the out-commuting areas and "Export positions" for the in-commuting areas, gives the result of the application of the adjusted Midcrest matrix to the employment numbers listed in the first column. The only exception to this statement is that in the tables which show employment as positions, the employment of Commuters Net Outflow in negative terms is not listed. However, the negative employment of Commuters Net Outflow was used in the mathematical operation leading to the determination of the vector of export positions. The mathematical solution included a negative number of export positions for Commuters Net Outflow equal to the total negative employment of this artificial industry. It is only in the tables and not in the mathematical operations that the negative numbers of Commuters Net Outflow are omitted.

The third column of each of the tables gives the ratios, by industry, of export employment to area employment which might also be described as the ratios of industry export to industry total. In the fourth column are listed the ratios of export employment by industry to the area export sum or in other words the ratios of industry export to total area export.

In the process of computing the estimated export employment for Iowa and for 16 administrative areas of Iowa, the very gratifying result was the capability of the model to produce results which could be accepted as realistic at least as a first approximation. With only one exception each area received an estimated export vector with all elements positive. The one exception is the Decorah area described by Table 82 for which the computations produced small negative export numbers for the sectors of Finance and Related and Services and Related. Comments concerning the results for the Decorah area are included at a later point.

An almost unlimited amount of discussion might be presented with regard to the results for the state administrative areas. In general, this potential discussion might be summarized by saying that none of the export estimation results seem to conflict in any substantial way with rough estimates that might be made on the basis of information available from the Census of Manufactures, County Business Patterns data, Census of Business or intuitive estimates that have been made by persons of the author's acquaintance who are personally acquainted with the situations in one or more of the areas.

The previous sentence should not be interpreted as an effort by the author to "prove" the reliability of the model by any loosely constructed appeals to reason or to experience. The point of intuitive realism is made only because it is this test that is so often failed by the macrocosmic, fixed industry export percentage and polar methods of export estimation.

Some readers may note that the over-all ratio of export employment to total employment, the bottom number of the third column of each table, remains remarkably close to 0.5 in spite of the wide variation in area employment. This result seems at first glance to run counter to export base theory and even to the rationale for the use of the adjustment multiplier for area size which is a part of the model of this study. One would expect that as larger areas are encountered the proportion of employment that can be designated as export should be noticeably smaller as a part of total employment.

For the entire Iowa area with an employment much larger than any of its administrative areas taken singly, the export proportion computed by the model is 0.41782 of total employment. This can be said to be noticeably smaller than 0.5 in value. Why then is there so little variation in this ratio among the areas of Iowa?

The answer appears to lie almost entirely in the fact that Agriculture and Related has a larger multiplier effect upon total employment than any other major exporting industry of the areas. In the relatively small administrative areas, Agriculture and Related employment accounts for 70 percent or more of the export employment. In the largest Iowa administrative areas, Agriculture and Related employment accounts for less than 15 percent of the area export employment. The result is that as we look at areas of the largest total employment sizes we are observing areas for which the higher multiplier effect of large total area size is offset relative to small areas by the much lower proportion of export employment that is of the Agriculture and Related industry. When we observe the data for Iowa as a whole, we see a situation in which Agriculture a and Related accounts for the moderately large proportion of 42 percent of state export employment. In addition the effects of area size, where total employment is slightly over one million employees, have overwhelmed the effect of a lower proportion of Agriculture and Related export employment as compared to the most rural areas.

The negative export numbers found in the two sectors of the Decorah area would be very disturbing if this area were believed to be a typical small functional economic area. However, the author believes that of all the administrative areas of the state the Decorah area is the one that should most be expected to fall short of the residentiary employment pattern required by the model for an area of 26,578 employment. The result of the falling short is the generation of one or more negative export elements. Figure 7 shows that the Decorah area consists of four counties arranged with three in a row and with the fourth county below one of the end counties of the row. This geographical arrangement, the lack of a large central city, the travel distance conditions of the area and the encroachment of other functional economic areas all act as hindrances to the development of the area as a unit.

Decorah is the smallest of all the proposed administrative centers of the 16 state administrative areas. Its 1960 population, including Luther College students, was 6,435. Creston is the next smallest with a 1960 population of 7,667 and no college enrollment to swell the numbers.

Approximately three-fourths of the Clayton County population resides beyond a fifty mile driving distance from Decorah. At least two-thirds of the Clayton County population resides closer to either Oelwein, a town of 8,282 population in 1960, or to the city of Dubuque.

The fifty mile radius functional economic areas of Dubuque, Iowa, LaCrosse, Wisconsin, Rochester, Minnesota and Albert Lea, Minnesota reach deeply into the Decorah administrative area from three sides. This combination of influences should probably be expected to cause the true Decorah functional area to be smaller than the delineated state administrative area.

Tables 84 through 91 present previously reported information on state administrative areas in a format such that in each table comparisons may be made of the export results among areas for a specified industry. Reported for the first time in this set of tables are the results of application of the Midcrest matrix to the Winneshiek County Iowa data. This application was made only to illustrate that for an area, i.e., the Decorah area, for which the model did not work well, it is still possible to take a county of this area and apply the model with satisfactory results. This is not to imply that the model will work generally on all counties in Iowa or surrounding states. It may be that it does work on these smaller areas, but it has not yet been tried on more than a few. It is not considered to be within the range of objectives of this study to apply the model to areas of county size.

A few comments may be in order with regard to each of Tables 84 through 91. Table 84 on Agriculture and Related contains no startling information from the viewpoint of the author. It may be noted, however, that a rather wide variation exists in the third column which describes the relative importance of Agriculture and Related export as a part of "all industries" export. As might be expected, the more urban areas depend much less on Agriculture as an export base, It may surprise some

Table 84. Agriculture and Related 1960 employment by selected state administrative areas and by export employment and selected export ratios

State administrative area	Export employment	Ratio of Agriculture export to Agriculture total	Ratio of Agriculture export to all industries export
Iowa	179,297	0.83059	0.42112
Des Moines	12,050	0.69345	0.13465
Cedar Rapids	15,386	0.82805	0.26481
Waterloo	15,551	0.86664	0.35400
Davenport	5,236	0.71035	0.12646
Sioux City	15,862	0.88427	0.40250
Council Bluffs	14,862	0.88596	0.40043
Ottumwa	13,811	0.89624	0.44693
Mason City	16,880	0.91471	0.56472
Fort Dodge	11,356	0.90414	0.47031
Burlington	4,764	0.80910	0.19936
Dubuque	7,365	0.86985	0.31391
Spencer	11,841	0.92400	0.60250
Marshalltown	9,276	0.90906	0.48254

Table 84. (continued)

State administrative area	Export employment	Ratio of Agriculture export to Agriculture total	Ratio of Agriculture export to all industries export
Carroll	12,679	0.93724	0.73600
Decorah	11,347	0.94590	0.83538
Creston	9,458	0.94000	0.73582
Winneshiek County	3,418	0.96227	0.65541

Table 85. Construction and Related 1960 employment by selected state administrative areas and by export employment and selected export ratios

State administrative area	Export employment	Ratio of Construction export to Construction total	Ratio of Construction export to all industries export
Iowa	483	0.00860	0.00113
Des Moines	3,141	0.27591	0.03510
Cedar Rapids	643	0.10882	0.01107
Waterloo	149	0.03451	0.00339
Davenport	300	0.08139	0.00724
Sioux City	656	0.15119	0.01665
Council Bluffs	572	0.14693	0.01541
Ottumwa	758	0.27725	0.02453
Mason City	477	0.13964	0.01596
Fort Dodge	214	0.08803	0.00886
Burlington	313	0.14144	0.01310
Dubuque	138	0.06638	0.00588
Spencer	188	0.09078	0.00956
Marshalltown	234	0.11896	0.01217

Table 85. (continued)

State administrative area	Export employment	Ratio of Construction export to Construction total	Ratio of Construction export to all industries export
Carroll	208	0.10839	0.01208
Decorah	231	0.14574	0.01700
Creston	71	0.05437	0.00552
Winneshiek County	217	0.41571	0.04161

Table 86. Manufacturing and Related 1960 employment by selected state administrative areas and by export employment and selected export ratios

State administrative area	Export employment	Ratio of Manufacturing export to Manufacturing total	Ratio of Manufacturing export to all industries export
Iowa	138,029	0.73171	0.32419
Des Moines	30,268	0.86104	0.33821
Cedar Rapids	25,558	0.90602	0.43988
Waterloo	19,582	0.91130	0.44576
Davenport	22,178	0.92978	0.53564
Sioux City	9,930	0.85156	0.25197
Council Bluffs	1,993	0.59922	0.05370
Ottumwa	9,306	0.88950	0.30114
Mason City	6,948	0.85461	0.23244
Fort Dodge	6,811	0.88627	0.28208
Burlington	11,407	0.93515	0.47736
Dubuque	10,897	0.93416	0.46445
Spencer	3,100	0.81946	0.15774
Marshalltown	5,333	0.89510	0.27743

Table 86. (continued)

State administrative area	Export employment	Ratio of Manufacturing export to Manufacturing total	Ratio of Manufacturing export to all industries export
Carroll	1,874	0.76866	0.10878
Decorah	1,471	0.79256	0.10830
Creston	812	0.68897	0.06319
Winneshiek County	390	0.87640	0.07479

Table 87. Trade, Wholesale-Retail 1960 employment by selected state administrative areas and by export employment and selected export ratios

State administrative area	Export employment	Ratio of Trade export to Trade total	Ratio of Trade export to all industries export
Iowa	43,443	0.21518	0.10204
Des Moines	13,216	0.35722	0.14767
Cedar Rapids	5,913	0.27861	0.10177
Waterloo	4,426	0.26958	0.10075
Davenport	5,574	0.36103	0.13462
Sioux City	6,482	0.37068	0.16448
Council Bluffs	3,735	0.27716	0.10063
Ottumwa	2,835	0.25082	0.09174
Mason City	3,312	0.27531	0.11080
Fort Dodge	3,121	0.32145	0.12926
Burlington	3,033	0.35182	0.12693
Dubuque	2,350	0.29109	0.10016
Spencer	2,570	0.31380	0.13077
Marshalltown	2,062	0.28587	0.10727

Table 87. (continued)

State administrative area	Export employment	Ratio of Trade export to Trade total	Ratio of Trade export to all industries export
Carroll	1,569	0.23439	0.09108
Decorah	318	0.07270	0.02341
Creston	978	0.20908	0.07608
Winneshiek County	513	0.35331	0.09837

Table 88. Transportation and Related 1960 employment by selected state administrative areas and by export employment and selected export ratios

	Export employment	Ratio of Transportation export to Transportation total	Ratio of Transportation export to all industries export
Iowa	18,652	0.28764	0.04381
Des Moines	5,744	0.44083	0.06418
Cedar Rapids	1,456	0.24537	0.02506
Waterloo	1,891	0.35992	0.04304
Davenport	1,336	0.31450	0.03227
Sioux City	2,100	0.41469	0.05328
Council Bluffs	4,392	0.64051	0.11834
Ottumwa	1,758	0.43829	0.05689
Mason City	958	0.29900	0.03205
Fort Dodge	1,153	0.39896	0.04775
Burlington	1,810	0.52540	0.07574
Dubuque	715	0.30726	0.03048
Spencer	703	0.33270	0.03577
Marshalltown	1,096	0.45515	0.05702

Table 88. (continued)

State administrative area	Export employment	Ratio of Transportation export to Transportation total	Ratio of Transportation export to all industries export
Carroll	351	0.22145	0.02037
Decorah	200	0.17452	0.01472
Creston	424	0.32516	0.03301
Winneshiek County	213	0.50118	0.04084

Table 89. Finance and Related 1960 employment by selected state administrative areas and by export employment and selected export ratios

State administrative area	Export employment	Ratio of Finance export to Finance total	Ratio of Finance export to all industries export
Iowa	9,916	0.27302	0.02329
Des Moines	8,900	0.68689	0.09945
Cedar Rapids	1,266	0.33850	0.02179
Waterloo	626	0.25232	0.01425
Davenport	884	0.35374	0.02135
Sioux City	923	0.36182	0.02342
Council Bluffs	339	0.19675	0.00913
Ottumwa	124	0.09098	0.00401
Mason City	408	0.24878	0.01365
Fort Dodge	385	0.28861	0.01594
Burlington	220	0.19784	0.00921
Dubuque	297	0.25277	0.01266
Spencer	291	0.27453	0.01481
Marshalltown	298	0.28848	0.01550

Table 89. (continued)

State administrative area	Export employment	Ratio of Finance export to Finance total	Ratio of Finance export to all industries export
Carroll	55	0.07565	0.00319
Decorah	-52	-0.11255	-0.00381
Creston	53	0.10000	0.00414
Winneshiek County	20	0.15152	0.00384

Table 90. Services and Related 1960 employment by selected state administrative areas and by export employment and selected export ratios

State administrative area	Export employment	Ratio of Services export to Services total	Ratio of Services export to all industries export
Iowa	24,236	0.09951	0.05692
Des Moines	16,175	0.30653	0.18074
Cedar Rapids	7,880	0.25726	0.13562
Waterloo	1,705	0.08960	0.03881
Davenport	1,727	0.10078	0.04171
Sioux City	3,456	0.18504	0.08770
Council Bluffs	1,172	0.07906	0.03158
Ottumwa	1,193	0.10353	0.03861
Mason City	908	0.07194	0.03038
Fort Dodge	1,106	0.10821	0.04580
Burlington	2,349	0.21515	0.09830
Dubuque	1,700	0.16793	0.07246
Spencer	860	0.10327	0.04376
Marshalltown	924	0.11454	0.04807

Table 90. (continued)

State administrative area	Export employment	Ratio of Services export to Services total	Ratio of Services export to all industries export
Carroll	358	0.05507	0.02078
Decorah	-264	-0.05469	-0.01944
Creston	721	0.13167	0.05610
Winneshiek County	430	0.26045	0.08245

Table 91. Commuters Net Outflow 1960 employment by selected state administrative areas and by export employment and selected export ratios

State administrative area	Export employment	Ratio of Commuters export to Commuters total	Ratio of Commuters export to all industries export
Iowa	11,708	1.00000	0.02750
Davenport	4,170	1.00000	0.10071
Council Bluffs	10,050	1.00000	0.27078
Ottumwa	1,117	1.00000	0.03615
Spencer	100	1.00000	0.00509
Carroll	133	1.00000	0.00772
Decorah	332	1.00000	0.02444
Creston	336	1.00000	0.02614
Winneshiek County	14	1.00000	0.00269

readers to observe that the areas of Des Moines and Davenport have less than 15 percent of their export employment in the Agriculture and Related industry.

Table 85 on Construction and Related employment illustrates a rather simple point concerning economic base theory that is sometimes forgotten. In comparing Iowa with the Des Moines administrative area, it can be observed that the latter has a much larger export employment in this industry than does the Iowa area of which the Des Moines area is a part. A possible reason is that the Des Moines area exports construction activity to other parts of Iowa but not any substantial amount beyond the borders of Iowa. From the standpoint of Iowa as a whole this within-state exporting by the Des Moines area is simply a part of Iowa's residentiary activity.

The third column illustrates that Construction and Related export is not a substantial part of total export activity for the state or for any of the areas.

Table 86 on Manufacturing and Related employment can be used to show the relatively much greater importance of manufacturing as an export industry in the highly urban areas. There are no highly unusual or unexpected situations in this table.

Table 87 on Trade, Wholesale-Retail employment is interesting because of the relative uniformity of the areas in the columns of the selected export ratios. This result seems to be due primarily to the fact that in quite rural areas the wholesaling of farm products raw materials is about as important an industry relative to total Trade employment as is the wholesaling of consumer goods and agricultural inputs in the urban areas.

The one area which does not seem to fit the uniformity of ratios pattern of Table 87 is the Decorah area, but it must be remembered that when we have encountered negative exports in one or more sectors of the area, as is true in the Decorah case, the other export numbers should also be suspect. It may be noted that Winneshiek County, a part of the Decorah area, exhibits export ratios which are quite comparable to those of the other areas of Table 87.

Table 88 on Transport and Related employment exhibits what may appear to some readers to be rather high ratio values in the second column. In most areas this can be explained as being due to the relatively large amount of truck transportation involved in the transport of farm products out of the areas. In the more urban areas both wholesale trucking and railroad transportation centers may be involved. The latter is probably expecially important in the Council Bluffs area. The third column shows that Transport and Related is not a very large proportion of total export for any area.

Table 89 on Finance and Related shows the relative concentration of export activities of this sector in the Des Moines area. Only in the Des Moines area is this industry responsible for more than a very small proportion of total export of the area.

Export activity in Services and Related, illustrated in Table 90, is generally concentrated in the services of higher education and of state government. The Des Moines area, which includes both state government facilities and Iowa State University would be expected to show a strong export component within the industry. The table indicates that this is so. The Cedar Rapids area includes the State University of Iowa location, and again a relatively strong component of Services and Related export is indicated in the table.

An interesting observation for this table is that whereas the Decorah area showed a negative export element for the area as a whole, the Winneshiek County area exhibits a positive export employment of respectable size in this sector in relation to the size of the area. This condition for Winneshiek County is consistent with the location of Luther College within the county.

Table 91 on Commuters Net Outflow lists only the areas which have positive net out-commuting flows. These flows are, of course, considered entirely export so that the ratios of the second column are all equal to unity. Only the Davenport and Council Bluffs areas exhibit out-commuting flows which are important parts of the export activity of the areas.

C. Comparison with Other Studies

1. Mason City area manufacturing sector

In 1966 a study of the manufacturing sector of the Mason

City state administrative area was completed by Denis I. Lucey (27) under the direction of Professor Donald R. Kaldor of Iowa State University. The study was concerned with demand projections for the export manufacturing firms. In connection with the study a questionnaire was circulated to manufacturing firms of an area identical to the Mason City state administrative area except that Kossuth County was not included. In the questionnaire, firms were asked to describe their sales for 1962 by destination to locations inside and outside of the NIAD area. The information of this study was thus derived entirely independently from the Midcrest matrix estimation procedure, and it had a good primary data base. In the analysis of the data of the survey, Mr. Lucey (27, pp. 63-64) allocated the labor force of manufacturing according to area of market dependence. He arrived at the estimate that 84.4 percent of the manufacturing labor force of the NIAD area was dependent on sales to locations outside of the area. This may be compared to the corresponding estimate of 85.461 percent derived from the Midcrest matrix calculation on the 1960 employment data of the Mason City administrative area.

The almost perfect agreement of these two independently prepared estimates makes any detailed comment seem unnecessary. In this case an empirically derived estimate was duplicated almost exactly by a model constructed from the data of another area and relying on the hypothesis that the internal structures of areas are highly similar except for adjustments related to total area size in employment terms.

2. Fort Dodge area manufacturing sector

In 1964, field staff members of the Extension Service of Iowa State University conducted a survey similar to the Midcrest survey with firms of the manufacturing sector of Webster and Hamilton counties. These two counties together account for approximately 80 percent of the manufacturing activity of the Fort Dodge administrative area. The data from this survey and other information was used in the preparation of an economic base study of the Fort Dodge area (23). The division of the employment of each firm which responded to the survey into export and residentiary categories and a simple summing of the surveyed employment by categories has provided the data to compute the ratio of export employment to total employment of 0.87832 for the two counties. This may be compared with the ratio of 0.88627 that was derived from the export estimate computed through use of the Midcrest matrix model on the entire Fort Dodge administrative area. Again it appears that agreement between the two independently derived estimates is amazingly close.

3. Sioux City urbanized area

The Sioux City urban area was studied by Charles Leven in a project for which he acted as consultant to the Sioux City Planning Commission (26). A rather comprehensive system of social accounts was prepared for the Sioux City urban area, and in the process of the study a set of export estimates by industry was prepared on a value-added basis. The number of employees by industry was also reported in the study. Export ratios in employment terms may be computed from the data of the Leven study. Employees reported for each industry are divided into export and residentiary categores according to the proportions by which value-added produced in the industry is so divided. The selected export ratios which were prepared from the Leven data are presented in Table 92 in a format permitting easy comparison with comparable ratios that were estimated for the same approximate area by the Midcrest matrix model.

The Midcrest matrix, appropriately adjusted for size, was applied to the employment data of the Sioux City urbanized area as reported in the 1960 Population Census (45, p. 217). The census information describes the Sioux City urbanized area as consisting of parts of Woodbury County, Iowa, Dakota County, Nebraska, and Union County, South Dakota. The Leven study describes the Sioux City urban area as including Sioux City, Iowa, South Sioux City, Nebraska, North Sioux City, South Dakota, and Seargeant Bluff, Iowa. It is not certain, of course, that the census defined urbanized area and the Leven study area are identical for all boundary locations. However, it seems certain that no closer approximation of employment data for the area used by Leven can be obtained from any other source.

The Leven study lists the total number of employees of the Sioux City urban area as of 1958 at 32,205. The Population Census gives the total employment of the Sioux City urbanized

Table 92. Selected export ratios for Sioux City urban area by industry of employment and by alternate derivations from Leven's 1958 empirical study and from the Midcrest matrix computed export estimates for 1960

Industry of employment	Ratio of industry export to industry total		Ratio of industry export to all industries export	
	from empirical study	from matrix estimation	from empirical study	from matrix estimation
Agriculture and Related	0.67210	0.50939	0.00465	0.01156
Construction and Related	0.44109	0.33333	0.02182	0.03549
Manufacturing and Related	0.86147	0.91416	0.43591	0.37692
Trade, Wholesale-Retail	0.38256	0.58160	0.21932	0.29363
Transportation and Related	0.43362	0.59004	0.07210	0.09315
Finance and Related	0.42976	0.55846	0.03716	0.04459
Services and Related	0.37480	0.29716	0.20904	0.14466
All Industries	0.51380	0.56470	1.00000	1.00000

area as 37,174. On the basis of this comparison it appears that the census defined urbanized area includes more geographic territory. However, it must be realized that Leven was working without the 1960 Population Census data, and other secondary sources of employment data generally report about 10 percent less employment for comparable areas.

The export ratios derived by the Midcrest matrix estimation method are also presented in Table 92. Probably each reader must make his own estimate of the degree of agreement of each equivalent pair of ratios and of the overall comparability of the sets of ratios. The author's judgment is that while extremely close agreement does not exist, there is generally no case of obvious contradiction in any comparison. If the industries are ranked in order of importance as export sectors of the area, using industry export to all industries export ratios as the basis for ranking, both studies produce exactly the same ranking. The complete agreement on this score appeals to the author as a significant result of the comparison.

V. DISCUSSION

A. The Range of the Study

The effort to produce a workable model for the approximation of export activity of functional economic areas has taken us down a path full of obstacles. The goal of the effort was quite clear and reasonably simple and the path of research was in full view at all times, but the obstacles produced a number of diversionary issues that had to be resolved before progress could again be made toward the primary goal.

The simpler economic base models of earlier days generally contained little or nothing of the core of economic theory within them. A considerable effort was made to rigorously reconcile the input-output type of model used by the author with a simple macroeconomic model.

The autonomous nature of the export variable in export base theory can conceivably conflict with the reciprocal effects concept of international trade theory. Again, a considerable effort was made to show that, at least in the growth context, an increase in exports may be assumed without conflicting with the basic principles of international trade theory.

The empirical study of the Midcrest area, which was carried out for the purpose of uncovering the 1960 transactions matrix for that area, could not be expanded sufficiently due to lack of resources to disclose the transactions of all industries. As a result much <u>a priori</u> estimation of relationships was necessary in order to fill the cells of the technology matrix.

The application of the matrix to other areas, both larger and smaller than Midcrest in employment terms, required an adjustment procedure under which technology coefficients would be larger for larger areas and smaller for smaller areas. This necessitated the development of a somewhat complicated mathematical function which was required to take on specified values at extreme limit points of area size and at the point of the Midcrest area size and to behave smoothly between these points.

The last diversionary issue involved the construction of a model which would estimate the net commuting situation for a given area. This latter model is necessary in order to make the export approximation model work well for real areas which must differ significantly from true functional economic areas because of political boundary or census boundary considerations.

The sequence of procedures described above eliminated the obstacles lying in the otherwise clear path from the study of a small area to application of its technology matrix to all areas. The routine and easily duplicated procedure of export estimation calculation was next performed on six large relatively "pure" functional economic areas and on 16 state administrative areas which only approximated functional areas or parts of such areas. Finally special comparisons were made using three areas where empirical work, independent of this study, had been conducted.

B. Survival of the Hypothesis

The hypothesis that relative stability of the technology matrix exists among areas has not, in the author's opinion, been refuted by any of the information presented in this study. While neither the data nor the findings are in a form that permits significance tests by standard statistical methods, the author feels that the results of the testing of the Midcrest matrix on all of the Iowa areas and parts of surrounding states are such as to lend much support to the hypothesis.

Many readers may feel that the relatively close agreement of the approximation procedure results to the empircally derived estimates for certain sectors of the Fort Dodge, Mason City and Sioux City areas are the most significant items of evidence in favor of the hypothesis. The author does not dispute the importance of this evidence, but he is much more impressed by the ability of the matrix model to derive acceptable export estimates on all the areas treated with the possible exception of the Decorah administrative area. If a relatively uniform structure of residentiary activity relationships were not present in all the treated areas, it is almost inconceivable that the employment structure by industries of so many areas could happen to be such that, when multiplied against the appropriately adjusted Midcrest matrix, no negative export numbers would appear while at the same time almost every area would show one or two sectors with quite low export values. The doubtful reader who is mathematically adept might try a calculation for a number of areas for which the total sector employments are each either increased by 10 percent or decreased by 10 percent with the direction of change being determined in each case by the flip of a coin.

C. Uses of Export Estimation Procedure

1. Extension Service area development studies

The demand for economic studies for multi-county areas of Iowa and of other Midwestern states is likely to increase in the future. In the past the Cooperative Extension Service of Iowa State University has prepared economic studies for the areas surrounding Ottumwa, Mason City, Creston and Fort Dodge. Approximately ten additional studies of other Iowa areas are needed in the near future.

An important part of these economic studies is an estimation of the export base of the area. In the past, field surveys have been necessary to gather sufficient data to make even crude estimates of export activity. Each of these surveys must have involved a cost of several thousand dollars in terms of time spent by field extension agents, special survey personnel and central staff specialists.

By use of the technique developed by this study, the approximations of export activity can be made at a cost of one to two hundred dollars per area for years in which employment data by industry is available for individual areas.

2. Background for physical planning

The staff members of many city and regional planning commissions and of private consulting firms will be ready to use the export base approximation technique in order to add to the inventory of background information which is usually associated with a comprehensive planning study. The export approximation method of this study is adaptable to a wide range of area sizes and can be used for urban areas as small as 5,000 population or regional areas as large as several million population.

The estimates at the extreme ranges in size are likely to be less accurate than those for areas closer in size to the Midcrest area, but some loss of accuracy may not be detrimental if the information is wanted for general understanding purposes.

3. Basis for social sciences studies

The structure by industry of an area employment pattern can be substantially different when viewed in terms of export employment as compared to a view in terms of total employment. An industry which is only among the leaders in terms of total employment may be by far the dominant industry in terms of export employment. Conversely, another industry which is substantial in total employment terms may have only a negligible export component.

Sociologists and political scientists who are concerned with group attitudes and actions by the populations of cities or areas may be able to gain new insights by observing the export employment pattern of the cities or areas. It might be hypothesized, for example, that populations and their leaders adopt attitudes and attempt actions which they perceive as being beneficial to the export segments of their economies. Employees of residentiary oriented firms of many areas might have widely differing viewpoints on some topics with the differences being attributable to the variability of the export employment structures of the various areas.

The author is not attempting to make specific suggestions for future research in fields outside his own specialty. There may be no fruitful opportunities to associate group action research with export approximations. However, the point to be made is that if such opportunities or similar ones do emerge, the export approximations are available from this study or can be prepared very easily using the techniques of this study.

D. Opportunities for Further Research

In the author's view the basic demonstration of the workability of the small area technology matrix transfer method of export approximation has been made by this study. Future efforts might most profitably be concentrated on empirical studies which could be used for refinement of the technology coefficients for each cell of the eight industry matrix. At some point it may be desirable to expand the matrix to include a more disaggregated set of industries.

Future empirical research should preferably be conducted at about the time of the 1970 Population Census. The more nearly this goal is met the more certain the investigator can be that the area has not undergone a major employment shift between the times of the census enumeration and his own data collection. In addition, it is quite probable that the internal transactions relationship structure of all areas is changing steadily over time. For this reason also it is desirable to measure the relationships at the point in time at which the census procedure is measuring the total employment totals.

The determination of the time pattern of change of the transactions relationships and technology coefficients also requires a considerable research effort. A time change adjustment procedure analagous to the area size change procedure of this study needs to be perfected if we are to attempt to describe areas over time. The path of investigation opened by Hildebrand and Mace (19) in 1950 should be extended.

VI. SUMMARY

A number of investigators have wished to make estimates of export and residentiary activity in areas, regions or cities. Usually control totals of economic activity in either employment or dollars of value-added have been obtained from census data. Each census total has then been divided into export and residentiary categories by applying appropriate ratios against it. Various ratios have been obtained either by expensive and time consuming surveys of business firms of the areas being studied or by the use of crude approximations regarding the magnitude of the ratios to be used. These approximations are not necessarily made *a priori*, but are usually related to other studies of areas which are in some degree similar to the one for which approximations are needed.

The objective of this study is to develop a new method for the rapid and inexpensive quantitative estimation of the export structure of any functional economic area. The method relies on the hypothesis that the internal residentiary relationships of all functional economic areas have a basic similarity. The Midcrest area of Iowa was surveyed and studied intensively to attempt to uncover the inter-industry transactions structure of the area. The transactions information was arranged in the form of an input-output table in units equivalent to employment of the supplying industry. A technology matrix of input-output coefficients was created from the transactions table and was identified as the Midcrest technology matrix or simply as the Midcrest matrix.

The Midcrest matrix is constructed so that if it is post-multiplied by the vector of total industry employments of the 1960 Population Census, the vector of residentiary employments by industry is obtained. The residentiary employments vector can be subtracted from the total employments vector to yield the vector of export employments by industry.

The identical set of operations can be performed for any other area for which a vector of total employments by industry is available. The Midcrest matrix, after appropriate adjustment for area size, can be used to substitute for the unknown true technology matrix of the area under study.

The adjustment of the Midcrest matrix to allow for variation in area size in employment terms is a monotonic adjustment such that each coefficient becomes larger as area size is increased and becomes smaller as area size is decreased.

A special procedure was developed for use in the estimation of net commuting movements so that the Midcrest matrix transfer methods can be used on areas which differ considerably from true functional economic area delineations and consequently might have substantial commuting movements.

Six approximately "pure" Midwestern functional economic areas, sixteen state administrative areas of Iowa, Iowa as a whole and an Iowa county were treated with the Midcrest matrix transfer method of export vector approximation. The general degree of realism of the export estimates was judged to be highly satisfactory according to a number of testing standards.

The method of export approximation is expected to be highly useful to educational institutions working in area development projects and to public and private planners working on comprehensive development and physical planning projects.

A large amount of additional research could be initiated for the purpose of refining the Midcrest matrix coefficients, expanding the matrix into more sectors, verifying the area size adjustment procedure and tracing the secular change in coefficient values.

VII. LITERATURE CITED

1. Andrews, Richard B. Mechanics of the urban economic base: the base concept and the planning process. Land Economics 32: 69-84. 1956.

2. Andrews, Richard B. Mechanics of the urban economic base: causes and effects of change in the base ratios and the base ratio elements. III. Land Economics 31: 361-371. 1955.

3. Andrews, Richard B. Mechanics of the urban economic base: causes and effects of change in the base ratios and the base elements. II. Land Economics 31: 245-256. 1955.

4. Andrews, Richard B. Mechanics of the urban economic base: causes and effects of changes in the base ratios and the base elements. II. Land Economics 31: 245-256. 1955.

5. Andrews, Richard B. Mechanics of the urban economic base: a classification of base types. Land Economics 29: 343-350. 1953.

6. Andrews, Richard B. Mechanics of the urban economic base: the concept of base ratios. Land Economics 31: 47-53. 1955.

7. Andrews, Richard B. Mechanics of the urban economic base: the problem of base measurement. Land Economics 30: 164-172. 1954.

8. Andrews, Richard B. Mechanics of the urban economic base: historical development of the base concept. Land Economics 29: 161-167. 1953.

9. Andrews, Richard B. Mechanics of the urban economic base: the problem of base area delineation. Land Economics 30: 309-319. 1954.

10. Andrews, Richard B. Mechanics of the urban economic base: the problem of base measurement. Land Economics 30: 52-60. 1954.

11. Andrews, Richard B. Mechanics of the urban economic base: the problem of terminology. Land Economics: 29: 263-268. 1953.

12. Andrews, Richard B. Mechanics of the urban economic base: special problems of base identification. Land Economics 30: 260-269. 1954.

13. Blumenfeld, Hans. The economic base of the metropolis. American Institute of Planners Journal 21: 114-132. 1955.

14. Daly, M. C. An approximation to a geographical multiplier. Economic Journal 50: 248-258. 1940.

15. Eldridge, Eber. The economic base of Niad. Iowa State University of Science and Technology Cooperative Extension Service in Agriculture and Home Economics Publication RAD-37. 1964.

16. Eldridge, Eber and Julius, Marvin. The economic base of seven southern Iowa counties. Iowa State University of Science and Technology Cooperative Extension Service in Agriculture and Home Economics Publication RAD-52. 1965.

17. Fox, Karl A. and Kumar, T. Krishna. Delineating functional economic areas. In Iowa State University Center for Agricultural and Economic Development. Research and education for regional and area development. Pp. 13-55. Ames, Iowa, Iowa State University Press. 1966.

18. Fox, Karl A., Sengupta, Jati K. and Thorbecke, Erik. The theory of quantitative economic policy. Chicago, Illinois, Rand McNally and Company. 1966.

19. Hildebrand, George and Mace, Arthur, Jr. The employment multiplier in an expanding industrial market: Los Angelos County, 1940-47. Review of Economics and Statistics 32: 241-249. 1950.

20. Hoyt, Homer. Homer Hoyt on development of economic base concept. Land Economics 30: 182-191. 1954.

21. Hoyt, Homer. The utility of the economic base method in calculating urban growth. Land Economics 37: 51-58. 1961.

22. Iowa State Office for Planning and Programming. A regional delineation for the state of Iowa. To be published by Iowa State Office for Planning and Programming, Des Moines, Iowa. <u>ca.</u> 1968.

23. Julius, Marvin. The economic base of the Fort Dodge area. Iowa State University of Science and Technology Cooperative Extension Service in Agriculture and Home Economics Publication Pm-375. 1967.

24. Leontief, Wassily. Input-output economics. New York, New York, Oxford University Press. 1966.

25. Leontief, Wassily. The structure of the American economy, 1919-1939. New York, New York, Oxford University Press. 1951.

26. Leven, Charles L. An appropriate unit for measuring the urban economic base. Land Economics 30: 369-371. 1954.

27. Lucey, Denis Ignatius. Demand projections for the export manufacturing industries of northern Iowa. Unpublished M.S. thesis. Ames, Iowa, Library, Iowa State University of Science and Technology. 1966.

28. Mantilla, John M. and Thompson, Wilbur R. The measurement of the economic base of the metropolitan area. Land Economics 31: 215-228. 1955.

29. Martin, Lee R. Some thoughts on regional economic analysis. In Iowa State University for Agricultural and Economic Development. Research and education for regional and area development. Pp. 65-78. Ames, Iowa, Iowa State University Press. 1966.

30. National Economics Division Staff. The transactions table of the 1958 input-output study and revised direct and total requirements data. Survey of Current Business 45, No. 9: 33-49; 56. 1965.

31. Perloff, Harvey S., Dunn, Edgar S., Jr., Lampard, Eric E. and Muth, Richard F. Regions, resources and economic growth. Baltimore, Maryland, John Hopkins Press. 1960.

32. Pfouts, Ralph W. An empirical testing of the economic base theory. American Institute of Planners Journal 23: 64-69. 1957.

33. Powers, Ron. The economic base of Tenco. Iowa State University of Science and Technology Cooperative Extension Service in Agriculture and Home Economics Publication RAD-31. 1964.

34. Sioux City Planning Commission. Sioux City economic study. Sioux City, Iowa, author. ca. 1959.

35. Social Science Research Council Study Committee. Functional economic areas and consolidated urban regions of the United States. Unpublished mimeographed [final] report of study of principles of metropolitan area classification, directed by Brian J. L. Berry at the University of Chicago and sponsored by the Bureau of the Census, U.S. Department of Commerce. New York, New York, author. 1967.

36. Tiebout, Charles M. The communtiy economic base study. Committee for Economic Development Supplementary Paper 16. 1962.

37. Tiebout, Charles M. Exports and regional economic growth. Journal of Political Economy 64: 160-164. 1956.

38. Tiebout, Charles M. The urban economic base reconsidered. Land Economics 32: 95-99. 1956.

39. U.S. Bureau of the Budget. Office of Statistical Standards. Technical Committee on Industrial Classification. Standard industrial classification manual. Washington, D.C., author. 1957.

40. U.S. Census Bureau. County business patterns, first quarter 1962. Part 5A. 1963.

41. U.S. Census Bureau. 18th Census, 1960. Population, 1, Part 15. 1962.

42. U.S. Census Bureau. 18th Census, 1960. Population, 1, Part 51. 1961.

43. U.S. Census Bureau. 18th Census, 1960. Population, 1, Part 43. 1961.

44. U.S. Census Bureau. 18th Census, 1960. Population, 1, Part 1. 1962.

45. U.S. Census Bureau. 18th Census, 1960. Population, 1, Part 17. 1962.

46. U.S. Census Bureau. 18th Census, 1960. Population, 1, Part 25. 1961.

47. U.S. Census Bureau. 18th Census, 1960. Population, 1, Part 29. 1961.

48. U.S. Census Bureau. 18th Census, 1960. Population, 2, Part 6B. 1963.

49. U.S. Department of Agriculture. Agricultural Statistics, 1966.

50. Vanek, Jaroslav. International trade theory and economic policy. Homewood, Illinois. Richard D. Irwin, Inc. 1962.

51. Weimer, Arthur M. and Hoyt, Homer. Principles of urban real estate. New York, New York, The Ronald Press Company. 1939.

52. Weimer, Arthur M. and Hoyt, Homer. Principles of urban real estate. Revised edition. New York, New York, The Ronald Press Company. 1948.

VIII. ACKNOWLEDGMENTS

The list of persons who contributed critical items of information and interpretation which were imbedded into this study at various points is very long indeed. Only a selected group can be identified at this point, but the necessity for brevity does not reduce the author's debt to the many who are not named specifically.

Dr. Donald R. Kaldor gave freely of his time and his well-known talents for organization and for searching out the economic core of a path of analysis or of description. His assistance, expecially at the stage of building this study into an organized and unified whole, was invaluable. At the same time he permitted the greatest possible latitude to the author in the latter's attempt to pursue independent research. For both the careful guidance and the relative freedom, the author will remain grateful.

Dr. Eber Eldridge and the county extension personnel of the Midcrest area were responsible for the opportunity to gather the empirical data, the former by encouraging the data gathering as a class project in an off-campus economics course and the latter by being abundantly willing to carry out the project.

A number of community and area leaders of the Midcrest area with whom the author came into contact during an extension seminar series provided numerous insights into the economic organization of the area. These insights hopefully helped produce accurate estimates of export and residentiary activity for the sectors which were not surveyed.

Members of the author's family contributed with a patient willingness to forego some usual family activities while this dissertation was in progress. Without doubt, the greatest sacrifices were borne by the author's wife, Maxine, who had to assume more than a mother's share of the family responsibilities and who received in return much less than a wife's rightful share of a husband's time and attention.